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Tampa Electric Company proposes to construct and operate a 417 MW (NET) capacity coal-fired electric generating plant at the existing Big Bend complex adjacent to Hillsborough Bay in west-central Hillsborough County, Florida. The EIS examines project alternatives, impacts, and mitigative measures related to groundwater, air, surface water, ecological, and socioeconomic and cultural systems.

Volume 2 describes the environmental of the proposed project, discusses the environmental impacts of the proposed plant ~~and~~ as well as the mitigating measures and monitoring programs.

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Volume 2

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TABLE OF CONTENTS

Volume I

Page

CHAPTER 1 BACKGROUND 1-1

1.1 IDENTIFICATION OF APPLICANT 1-1

1.2 PROJECT OBJECTIVES 1-1

1.3 HISTORICAL AND PROJECTED NEED FOR POWER 1-2

1.4 RESERVE CAPACITY 1-3

1.5 ELECTRICAL DEMAND FORECAST METHODOLOGY EMPLOYED BY APPLICANT 1-4

  1.5.1 Trend Analysis 1-4
  1.5.2 Detailed End-Use Model 1-5
  1.5.3 Multivariate Demand Model 1-7
  1.5.4 Phosphate Demand and Energy Forecast 1-7

1.6 SUMMARY 1-8

REFERENCES 1-30

CHAPTER 2 DESCRIPTION OF AREA OF INTEREST 2-1

2.1 THE ATMOSPHERE 2-1

  2.1.1 Climate 2-1
    2.1.1.1 Regional Climatology 2-1
    2.1.1.2 Severe Weather 2-2
    2.1.1.3 Atmospheric Dispersion Conditions 2-3
  2.1.2 Air Quality 2-5

2.2 THE LAND 2-16

  2.2.1 Physiography and Topography 2-16
  2.2.2 Geology 2-16
  2.2.3 Soils 2-17
  2.2.4 Terrestrial Flora and Fauna 2-18
    2.2.4.1 Physiography 2-18
    2.2.4.2 Flora 2-18
    2.2.4.3 Fauna 2-21

2.3 THE WATER 2-65

  2.3.1 Identification 2-65
    2.3.1.1 Surface Water 2-65
    2.3.1.2 Ground Water 2-66

TABLE OF CONTENTS (Continued)

Page

3.2.1.10 Coal Gasification 3-6
3.2.1.11 Coal Liquefaction 3-6
3.2.1.12 Fusion Power 3-6
3.2.1.13 Oil and Natural Gas 3-7
3.2.1.14 Nuclear Technology (Uranium) 3-7
3.2.1.15 Coal 3-7
3.2.1.16 Possible New Developments 3-7
3.2.2 Summary 3-7
3.2.3 Conclusion 3-7

3.3 SITE ALTERNATIVES 3-8

3.3.1 Siting Criteria and Constraints 3-8
3.3.1.1 Criteria 3-8
3.3.1.2 Region of Study 3-8
3.3.1.3 Initial Screening 3-9
3.3.1.4 Second-Stage Screening 3-11
3.3.1.5 Site Selection and Evaluation 3-11
3.3.2 Alternative Site Comparisons 3-11
3.3.2.1 Ranking the Candidate Sites 3-11
3.3.2.2 Ultimate Generating Capacity of Candidate Sites 3-14
3.3.2.3 Summary 3-14
3.3.2.4 Conclusion 3-15

3.4 ALTERNATIVE PLANT SYSTEMS 3-29

3.4.1 Alternative Waste-Heat-Rejection Systems 3-29
3.4.1.1 Introduction 3-30
3.4.1.2 Once-Through Cooling with Conventional Screens 3-31
3.4.1.3 Once-Through Cooling with Dilution 3-31
3.4.1.4 Cooling Towers with Saltwater Makeup 3-32
3.4.1.5 Cooling Towers with Treated Wastewater Makeup 3-34
3.4.1.6 Economic Analysis 3-34
3.4.2 Alternative Atmospheric Pollution Control Systems 3-34
3.4.2.1 Sulfur Dioxide Control Alternatives 3-34
3.4.2.2 Particulate Control Alternatives 3-38
3.4.2.3 Oxides of Nitrogen 3-40
3.4.2.4 Carbon Monoxide 3-40
3.4.2.5 Summary 3-40
3.4.3 Alternative Plant Water and Wastewater Systems 3-41
3.4.3.1 Alternative Makeup Water Sources 3-41
3.4.3.2 Alternative Wastewater Systems 3-41
3.4.4 Alternative Solid-Waste-Disposal Schemes 3-42
3.4.4.1 Introduction 3-42
3.4.4.2 Alternate Waste-Management Schemes 3-43

TABLE OF CONTENTS (Continued)

Page

2.8 SENSITIVE AREAS 2-182

2.8.1 Sensitive Geologic Areas 2-182
2.8.2 Forest and Woodland 2-182
2.8.3 Prime Agricultural Lands 2-182
    2.8.3.1 Types and Sizes of Farms 2-183
    2.8.3.2 Crops 2-183
    2.8.3.3 Crop Productivity 2-183
2.8.4 Habitats of Rare and Endangered Species 2-183
    2.8.4.1 Flora 2-183
    2.8.4.2 Fauna 2-185
2.8.5 Wetlands 2-201
2.8.6 Flood Plains or Flood Retention Areas 2-201
2.8.7 Surface Waters 2-202
    2.8.7.1 Dredge-and-Fill Operations 2-202
    2.8.7.2 Industrial Pollution and Sewage Contamination 2-203
    2.8.7.3 Thermal Discharge 2-203
    2.8.7.4 Beach Erosion 2-203
2.8.8 Ground-Water Recharge 2-204
2.8.9 Recreation Areas 2-205
    2.8.9.1 Existing Areas 2-205
    2.8.9.2 Future Areas 2-206
2.8.10 Archaeological and Historic Sites 2-206

REFERENCES 2-219

CHAPTER 3 ALTERNATIVES 3-1

3.1 MANAGEMENT ALTERNATIVES 3-1

3.1.1 No Action 3-1
3.1.2 Purchase of Power 3-1
3.1.3 Uprating of Older Units 3-1
3.1.4 Reactivation of Retired Facilities 3-2
3.1.5 Joint Projects with Adjacent Utilities 3-2
3.1.6 Construction of a Smaller Facility 3-2

3.2 POWER GENERATION ALTERNATIVES 3-3

3.2.1 Introduction 3-3
    3.2.1.1 Geothermal Technology 3-3
    3.2.1.2 Fuel Cells 3-3
    3.2.1.3 Hydroelectric and Pumped Storage 3-4
    3.2.1.4 Solar Thermal Technology 3-4
    3.2.1.5 Photovoltaic Cells 3-5
    3.2.1.6 Municipal Solid Wastes 3-5
    3.2.1.7 Fuels from Biomass 3-5
    3.2.1.8 Windpower 3-6
    3.2.1.9 Magnetohydrodynamics 3-6

TABLE OF CONTENTS (Continued)

Page

2.3.2 Water Quantity 2-66
    2.3.2.1 Surface Water 2-66
    2.3.2.2 Ground Water 2-67
2.3.3 Water Quality 2-68
    2.3.3.1 Chemical Description 2-68
    2.3.3.2 Sewage Treatment Plants 2-71
    2.3.3.3 Ground Water 2-71
2.3.4 Water Use 2-72
    2.3.4.1 Surface Water 2-72
    2.3.4.2 Ground Water 2-72
2.3.5 Aquatic Flora 2-73
    2.3.5.1 Phytoplankton 2-73
    2.3.5.2 Macrophytes 2-76
2.3.6 Aquatic Fauna 2-78
    2.3.6.1 Zooplankton 2-78
    2.3.6.2 Benthic Invertebrates 2-81
    2.3.6.3 Fishes 2-83
    2.3.6.4 Aquatic Mammals 2-84
    2.3.6.5 Commercial Fisheries 2-85
2.3.7 Significant Aquatic Habitats 2-86

2.4 DEMOGRAPHY 2-166

2.4.1 Existing Population 2-166
2.4.2 Future Population 2-166

2.5 ECONOMICS 2-169

2.5.1 Present 2-169
2.5.2 Future 2-169

2.6 LAND USE 2-170

2.6.1 Existing Land Use 2-170
    2.6.1.1 Agricultural Land Use 2-170
    2.6.1.2 Residential Land Use 2-170
    2.6.1.3 Commercial Land Use 2-171
    2.6.1.4 Industrial Land Use 2-172
2.6.2 Future Land Use 2-173
    2.6.2.1 Future Agricultural Land Use 2-173
    2.6.2.2 Future Residential Land Use 2-173
    2.6.2.3 Future Commercial Land Use 2-174
    2.6.2.4 Future Industrial Land Use 2-176

2.7 TRANSPORTATION 2-179

2.7.1 Railroads 2-179
2.7.2 Highways 2-179
2.7.3 Airports 2-179
2.7.4 Waterways 2-180

TABLE OF CONTENTS (Continued)

Page

3.4.4.3 Evaluation of Alternative Disposal Schemes 3-44
3.4.4.4 Summary 3-44
3.4.5 Alternative Transmission Systems 3-44

REFERENCES 3-61

CHAPTER 4 PROPOSED PROJECT 4-1

4.1 LOCATION AND PLAN OF PROJECT 4-1

4.2 PLANT ELEMENTS 4-5

4.2.1 General Description 4-5
4.2.2 Steam and Electric Power Generation Systems 4-6
4.2.3 Plant Water Systems 4-6
4.2.3.1 Station Water Use 4-6
4.2.3.2 Makeup Demineralizer System 4-6
4.2.3.3 Condensate-Polishing Demineralizer System 4-7
4.2.3.4 Cooling-Water System 4-8
4.2.3.5 FGD System 4-8
4.2.3.6 Bottom-Ash Sluice System 4-8
4.2.3.7 Fly Ash, Pyrites, and Economizer Sluice System 4-8
4.2.3.8 Other Water Uses 4-8
4.2.3.9 Chemical and Biocide Wastes 4-8
4.2.3.10 Chemical Wastes 4-9
4.2.3.11 Wastewater-Treatment System 4-12
4.2.3.12 Sanitary Wastes 4-15
4.2.4 Condenser-Cooling-Water System 4-16
4.2.4.1 Existing Units 4-16
4.2.4.2 Proposed Unit 4-17
4.2.5 Flue-Gas-Treatment System 4-21
4.2.5.1 Overview of Technology Availability 4-21
4.2.5.2 Coal Fuel 4-22
4.2.5.3 Arrangement of Flue-Gas-Treatment System 4-22
4.2.5.4 Selection of Flue-Gas Treatment 4-22
4.2.5.5 Influences on Flue-Gas Composition Incidental to SO_2 Scrubbing 4-25
4.2.5.6 Stack Discharge 4-25
4.2.6 Plant Solid-Waste System 4-26
4.2.6.1 Introduction 4-26
4.2.6.2 Solid-Waste Production 4-26
4.2.6.3 FGD System By-Product Storage/Disposal Area 4-27
4.2.7 Dock Facilities 4-29
4.2.8 Fuel-Handling and Storage Facilities 4-29
4.2.9 Transmission Facilities 4-29
4.2.10 Atmospheric Emissions 4-30
4.2.10.1 Regulatory Emission Requirements 4-30
4.2.10.2 Emissions 4-32
4.2.11 Noise Emissions 4-36

TABLE OF CONTENTS (Continued)

Page

4.3 CONSTRUCTION SCHEDULE, FACILITIES, AND MANPOWER 4-72

- 4.3.1 Schedule and Manpower 4-72
- 4.3.2 Construction of Major Plant Facilities 4-72
- 4.3.3 Temporary Construction Facilities 4-72

REFERENCES 4-73

Volume 2

CHAPTER 5 ENVIRONMENTAL SETTING OF PROPOSED PROJECT 5-1

5.1 ATMOSPHERE 5-1

- 5.1.1 Climatology and Meteorology 5-1
  - 5.1.1.1 Meteorological Monitoring Programs 5-1
  - 5.1.1.2 Site Meteorology 5-1
  - 5.1.1.3 Coastal Effects 5-1
- 5.1.2 Ambient Air Quality 5-5
  - 5.1.2.1 Ambient Air Quality Standards and Prevention of Significant Deterioration Increment 5-5
  - 5.1.2.2 Methodology of Ambient Air Monitoring 5-6
  - 5.1.2.3 Baseline Ambient Air Quality: Data Analysis 5-8
- 5.1.3 Ambient Noise 5-11

5.2 LAND 5-39

- 5.2.1 Physiography and Topography 5-39
- 5.2.2 Geologic Setting 5-39
  - 5.2.2.1 Site Bedrock Geology 5-39
  - 5.2.2.2 Subsurface Soil and Rock Conditions 5-39
  - 5.2.2.3 Seismicity 5-42
  - 5.2.2.4 Subsurface Investigations 5-42
- 5.2.3 Surficial Soils 5-43
- 5.2.4 Terrestrial Flora and Fauna 5-44
  - 5.2.4.1 Flora 5-45
  - 5.2.4.2 Fauna 5-47

5.3 WATER 5-150

- 5.3.1 Hydrology 5-150
  - 5.3.1.1 Surface Water 5-150
  - 5.3.1.2 Ground Water 5-152

- 5.3.2 Water Quality 5-154
  - 5.3.2.1 Hillsborough Bay and Big Bend Area 5-154
  - 5.3.2.2 Ground Water 5-156
- 5.3.3 Water Usage 5-156

TABLE OF CONTENTS (Continued)

Page

5.3.4 Aquatic Ecology 5-156
  5.3.4.1 Phytoplankton 5-156
  5.3.4.2 Macrophytes 5-158
  5.3.4.3 Zooplankton 5-159
  5.3.4.4 Benthic Invertebrates 5-164
  5.3.4.5 Fishes 5-172
  5.3.4.6 Aquatic Mammals 5-175

5.4 DEMOGRAPHY 5-327

5.5 ECONOMY 5-332

5.5.1 Existing Economy of Hillsborough County 5-332
  5.5.1.1 Personal Income 5-332
  5.5.1.2 Employment and Labor Force 5-332
  5.5.1.3 Local Government 5-332
  5.5.1.4 Sales, Income Tax, and Bank Deposits 5-332
  5.5.1.5 Housing 5-333
5.5.2 Future Economy 5-333
5.5.3 Local Community Services 5-334
  5.5.3.1 Electric Power, Water, and Wastewater Treatment 5-334
  5.5.3.2 Hospitals 5-334
  5.5.3.3 Garbage Collection 5-335
  5.5.3.4 Schools 5-335

5.6 LAND USE 5-343

5.6.1 Agricultural Land 5-343
5.6.2 Residential Land 5-343
5.6.3 Industrial and Commercial Land 5-343
5.6.4 Recreational Land 5-343
5.6.5 Historical and Archaeological Sites 5-344
5.6.6 Future Land Use 5-344

5.7 TRANSPORTATION 5-353

5.7.1 Highways 5-353
5.7.2 Railroads 5-353
5.7.3 Bus Service 5-353
5.7.4 Air Transportation 5-353
5.7.5 Port of Tampa 5-354

5.8 AESTHETIC QUALITIES 5-356

5.9 SENSITIVE AREAS 5-358

TABLE OF CONTENTS (Continued)

Page

5.10 RELATIONSHIP OF PROPOSED PROJECT TO OTHER LAND-USE PROJECTS 5-359

REFERENCES 5-360

CHAPTER 6 ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT 6-1

6.1 PRIMARY CONSTRUCTION IMPACTS 6-1

- 6.1.1 Atmosphere 6-1
  - 6.1.1.1 Air Quality 6-1
  - 6.1.1.2 Noise 6-1
- 6.1.2 Land 6-2
- 6.1.3 Water 6-4
- 6.1.4 People 6-7
  - 6.1.4.1 Socioeconomics 6-7
  - 6.1.4.2 Cultural and Historical Sites 6-9
  - 6.1.4.3 Aesthetic Quality 6-10
- 6.1.5 Sensitive Areas 6-10
- 6.1.6 Transmission-Line Construction Impacts 6-11

6.2 SECONDARY CONSTRUCTION IMPACTS 6-15

- 6.2.1 Atmosphere 6-15
- 6.2.2 Land 6-15
- 6.2.3 Water 6-15
- 6.2.4 People 6-15
  - 6.2.4.1 Induced Employment 6-15
  - 6.2.4.2 Induced Expansion of Disposable Income 6-15
  - 6.2.4.3 Housing and Community Facilities 6-16
  - 6.2.4.4 Land Use 6-16
  - 6.2.4.5 Transportation 6-16
  - 6.2.4.6 Cultural and Historical Sites 6-16
  - 6.2.4.7 Aesthetic Quality 6-16
- 6.2.5 Sensitive Areas 6-16

6.3 PRIMARY OPERATIONS IMPACT 6-17

- 6.3.1 Atmosphere 6-17
  - 6.3.1.1 General Meteorological Effects 6-17
  - 6.3.1.2 Dispersion Modeling 6-17
  - 6.3.1.3 Meteorological Data Modeling Input 6-18
  - 6.3.1.4 PSD Increment Consumption Methodology 6-19
  - 6.3.1.5 AAQS Impact Determination Methodology 6-20
  - 6.3.1.6 Background TSP Estimation 6-22
  - 6.3.1.7 Determination of Federal PSD Baseline 6-23
  - 6.3.1.8 Determination of State of Florida PSD Baseline 6-24

TABLE OF CONTENTS (Continued)

Page

6.3.1.9 PSD Increment Consumption 6-25
6.3.1.10 Compliance with AAQS 6-27
6.3.1.11 Maximum Incremental Impact and Nonattainment Area Impact 6-28
6.3.1.12 Worst-Case Meteorology 6-28
6.3.1.13 Additional Impacts 6-29
6.3.1.14 Cooling-Tower Impacts 6-30
6.3.1.15 Noise 6-31
6.3.2 Land 6-32
6.3.2.1 Powerplant Operation 6-32
6.3.2.2 Operation of a Mechanical-Draft Cooling Tower 6-34
6.3.3 Water 6-39
6.3.3.1 Surface Water 6-39
6.3.3.2 Ground Water 6-43
6.3.3.3 Aquatic Ecology 6-49
6.3.4 People 6-73
6.3.4.1 Employment 6-73
6.3.4.2 Wages of Operating and Maintenance Personnel 6-74
6.3.4.3 Community Facilities and Housing 6-74
6.3.4.4 Transportation 6-74
6.3.4.5 Land Use 6-74
6.3.4.6 Radionuclide Emissions 6-74
6.3.4.7 Contamination of Electrical Equipment from Cooling-Tower Operation 6-76

6.4 SECONDARY OPERATIONS IMPACTS 6-184

6.4.1 Atmosphere 6-184
6.4.1.1 Sulfates, Acid Rain, and Visibility 6-184
6.4.1.2 Ozone 6-186
6.4.2 Land 6-188
6.4.3 Water 6-188
6.4.4 People 6-190
6.4.4.1 Socioeconomics 6-190

6.5 LONG-TERM VERSUS SHORT-TERM IMPACTS 6-194

6.6 COMMITMENTS OF RESOURCES 6-195

6.7 UNAVOIDABLE ADVERSE IMPACTS 6-199

6.8 PROJECTED IMPACTS ON SPECIAL STATUS SPECIES 6-200

6.8.1 Species Included in the Federal List of Endangered Species 6-200
6.8.1.1 Brown Pelican 6-200
6.8.1.2 Southern Bald Eagle 6-200
6.8.1.3 West Indian Manatee 6-201

TABLE OF CONTENTS (Continued)

Page

6.8.1.4 Sea Turtles 6-201
6.8.1.5 Peregrine Falcon 6-201
6.8.2 Species Included in the Federal List of Threatened Species 6-202
6.8.2.1 Eastern Indigo Snake 6-202
6.8.2.2 American Alligator 6-202

REFERENCES 6-205

CHAPTER 7 MITIGATIVE MEASURES AND MONITORING PROGRAMS 7-1

7.1 MITIGATIVE MEASURES 7-1

7.1.1 Dust Control 7-1
7.1.1.1 Construction Dust Control 7-1
7.1.1.2 Operation Dust Control 7-1
7.1.2 Surface-Runoff-Pollution Control 7-2
7.1.2.1 Construction Impact Control 7-2
7.1.2.2 Operation Impact Control 7-2
7.1.3 Air-Pollution Mitigation 7-4
7.1.3.1 Background 7-4
7.1.3.2 Potential Off-Specification Operation of the Flue-Gas Emission-Control Facilities 7-4
7.1.4 Garbage-Disposal Services 7-4

7.2 MONITORING PROGRAMS 7-6

7.2.1 Construction Impact Monitoring Programs 7-6
7.2.1.1 Responsibilities 7-6
7.2.1.2 Monitoring Programs 7-6
7.2.1.3 Program Implementation 7-9
7.2.2 Air Quality 7-9
7.2.3 Operational Monitoring Program 7-9

REFERENCES 7-10

LIST OF TABLES

Volume 1

Table	Title	Page
1-1	Tampa Electric Company system net capabilities, December 31, 1979	1-9
1-2	History and forecast of energy use for Tampa Electric Company	1-10
1-3	History and forecast of seasonal peak demand and annual energy requirements for Tampa Electric Company	1-11
1-4	Forecast of capacity, demand, and scheduled maintenance during summer peak for Tampa Electric Company	1-12
1-5	Projected capacity, demand, and scheduled maintenance during winter peak for Tampa Electric Company	1-13
1-6	Tampa Electric Company interties	1-14
1-7	System capability additions and reductions for Tampa Electric Company and other Peninsular Florida Coordinating Group utilities, 1980-1988	1-15
1-8	Ten-year forecasts of capacity and demand during summer and winter peaks for Tampa Electric Company	1-19
2-1	Climatological normals, means, and extremes for Tampa International Airport	2-6
2-2	Climatological normals, means, and extremes for MacDill Air Force Base	2-7
2-3	Rainfall in inches for 0.5-, 1-, 6-, 12-, and 24-hour rainfall at 1- to 50-year frequencies	2-8
2-4	Mean regional afternoon mixing levels	2-8
2-5	Annual average wind speed summary	2-8
2-6	Monthly average wind speeds for Tampa International Airport	2-9
2-7	Atmospheric stability categories	2-9
2-8	Annual atmospheric stability summary	2-10
2-9	Monthly atmospheric stability summaries for Tampa International Airport	2-10
2-10	Common herbaceous plants in old fields	2-29
2-11	Common woody and herbaceous plants associated with cabbage palm hammocks	2-30
2-12	Characteristic plants of the live oak hammock	2-31
2-13	Characteristic plants of the mesic hammock	2-32
2-14	Characteristic plants of the wet prairie	2-33
2-15	Amphibians and reptiles whose geographic ranges include the Big Bend site	2-34
2-16	Relative abundance of amphibians and reptiles in habitats that occur on or near the Big Bend site	2-37
2-17	Relative abundance of birds in habitats that occur on or near the Big Bend site	2-40

LIST OF TABLES (Continued)

Table	Title	Page
2-18	Mammals, excluding manatees, whales, and dolphins, whose geographic ranges include the Big Bend site	2-50
2-19	Relative abundance of mammals for habitats that occur on or near the Big Bend site	2-52
2-20	Annual means and ranges of selected chemical parameters for subareas of the Tampa Bay estuary, 1962	2-88
2-21	Total Kjeldahl nitrogen and total phosphorus in subareas of the Tampa Bay estuary	2-89
2-22	Annual means and ranges of salinity in subareas of the Tampa Bay estuary	2-89
2-23	Average concentration of selected trace metals in Tampa Bay and in ocean water	2-90
2-24	Major wastewater sources affecting Tampa and Hillsborough Bays	2-91
2-25	Surface values of chlorophyll a, 1952-1966, and primary production of carbon, 1962-1966, for areas of Tampa Bay, Florida	2-93
2-26	Ranges of abundance of phytoplankton cells recorded from aliquots for the Tampa Bay system, fall 1969 to spring-summer 1971	2-96
2-27	Algae reported from the Tampa Bay area	2-99
2-28	Seasonal abundance of zooplankton in the Tampa Bay complex	2-103
2-29	Biomass contribution of various components of the zooplankton in the Tampa Bay system, 1969-1970	2-104
2-30	Plankton abundance, chlorophyll, and salinity values for various regions of the Tampa Bay system, 1969-1970	2-105
2-31	Abundance of the most numerous types of holoplankton in various regions of the Tampa Bay system, 1969-1970	2-106
2-32	Abundance of major larval plankton groups in various regions of the Tampa Bay system, 1969-1970	2-107
2-33	Total mean densities of ichthyoplankton and planktonic stages of commercially important invertebrates taken at the intake station located near the A. W. Higgins Powerplant and bay stations in upper Old Tampa Bay from March through November 1978	2-108
2-34	Scientific and common names of fishes and invertebrates taken in Tampa Bay macrozooplankton collections	2-111
2-35	Macroinvertebrates reported from Tampa Bay	2-115
2-36	Annelids, mollusks, and echinoderms reported from Tampa Bay	2-118
2-37	Relation between mollusk diversity and abundance, sediment type, and hydrologic conditions in four areas of Tampa Bay	2-124
2-38	Fishes reported from the Tampa Bay area	2-125
2-39	Occurrence of fishes in the Tampa Bay area	2-136
2-40	Fish species occurring in 1 percent or more of beach seine and trawl collections in Tampa Bay, 1961-1964	2-148

LIST OF TABLES (Continued)

Table	Title	Page
2-41	Seasonal occurrence of dominant young-of-year fish in Tampa Bay, 1961-1964	2-148
2-42	List of fishes killed by red tide and found floating in a boat basin in Boca Ciega Bay, Pinellas County, Florida, October 3, 1957	2-149
2-43	List of fishes killed by red tide and found on a 1,030-foot stretch of uncleared Gulf of Mexico beach just north of Madeira Beach, Pinellas County, Florida, October 3, 1957	2-150
2-44	Aquatic mammals whose geographic ranges include Tampa Bay and adjacent waters of the Gulf of Mexico	2-151
2-45	Commercial catch data for fishes landed in the Tampa Bay area and along the entire Florida west coast from 1966 to 1976	2-152
2-46	Commercial catch data for important invertebrates landed in the Tampa Bay area from 1966 to 1976	2-153
2-47	Commercial fishery data for the catch landed in the Tampa Bay area during 1976	2-154
2-48	Fishes and invertebrates that are important in Gulf of Mexico fisheries and inhabit the Tampa Bay system in early developmental stages	2-156
2-49	Area of oyster beds and area closed to shellfishing by state and county governments in the Tampa Bay system	2-157
2-50	Results of a survey of pier fishermen in Pinellas County conducted by the National Marine Fisheries Service to determine the composition and seasonal distribution of local sports fishes	2-157
2-51	Areal extent of emergent and submerged aquatic vegetation in the Tampa Bay system	2-158
2-52	Areal extent of filled and drained areas in the Tampa Bay system	2-158
2-53	Total population and population density for counties in study area	2-167
2-54	Incorporated places over 10,000 population	2-167
2-55	Future populations of counties within the study area	2-168
2-56	Agricultural acreage, 1974	2-177
2-57	Change in agricultural acreage, 1969-1974	2-178
2-58	Land use on Hillsborough County farms for 1969 and 1974	2-207
2-59	Aquatic invertebrates of special status that have been reported from the Tampa Bay area	2-207
2-60	Fishes of special status that have been reported from the Tampa Bay area	2-208
2-61	Terrestrial invertebrates of special status that occur in Florida	2-209
2-62	Amphibians and reptiles of special status that could occur on or near the Big Bend site	2-210
2-63	Birds of special status whose ranges include the Big Bend site	2-211

LIST OF TABLES (Continued)

Table	Title	Page
2-64	Mammals of special status that could occur on or near the Big Bend site	2-213
2-65	Number and type of historic sites by county	2-214
2-66	Number of National Register historic sites by county	2-215
2-67	Number and type of archaeological sites by county	2-216
3-1	Siting characteristics and relative weights	3-16
3-2	Summary of site suitability	3-17
3-3	Variations in the weighting system	3-18
3-4	Rating change A	3-19
3-5	Rating change B	3-20
3-6	Comparison of results from the weighting and rating combination	3-21
3-7	Cost summary	3-22
3-8	Composite analysis of sites and principal criteria to determine ultimate power generation capacity	3-23
3-9	Combinations of powerplant size to meet site ultimate capacity	3-24
3-10	Major cost penalties associated with operation of alternative waste-heat-rejection systems	3-45
3-11	Costs and effectiveness of coal-pretreatment processes of physical versus chemical cleaning	3-46
3-12	Utility and energy penalties for alternative FGD systems	3-46
3-13	Capital and annual costs for alternative FGD systems	3-47
3-14	Emission test results for fabric-filter systems on coal-fired steam generators	3-48
3-15	Atmospheric pollution control systems	3-49
4-1	Water use at Big Bend Station	4-38
4-2	Expected influents and effluents of the demineralizer system for Big Bend Units 3 and 4	4-41
4-3	Chemical composition of freshwater wastes	4-43
4-4	Wastewater-recycle design flows	4-45
4-5	Flow and velocity characteristics of the condenser-cooling-water systems for Big Bend Units 1-4	4-45
4-6	Wastewater recycle design flows associated with Big Bend Unit 4	4-46
4-7	Design coal analyais	4-47
4-8	Solid wastes produced by Big Bend Station Unit 4	4-48
4-9	Production rate of fly ash and bottom ash from Big Bend Station Unit 4	4-48
4-10	Full-load operating and emission parameters for Big Bend Station	4-49
4-11	New source performance standards for electric utility steam-generating units	4-50
4-12	Florida emission limiting standard for new solid fossil fuel steam generators	4-50
4-13	Pollutant emissions summary for Big Bend Station Unit 4	4-51

LIST OF TABLES (Continued)

Table	Title	Page
4-14	Full-load boiler performance data for Big Bend Station Unit 4	4-51
4-15	Summary of fugitive dust emissions from coal-handling operations at Big Bend Station Unit 4	4-52
4-16	Type and control efficiency for coal storage piles	4-53
4-17	Potential and controlled fugitive emissions from limestone storage pile	4-53
4-18	Emission rates and stack parameters for the Big Bend Station Unit 4 limestone- and fly-ash-handling systems	4-53
4-19	Construction sound levels of Big Bend Station Unit 4	4-54
4-20	Predicted maximum operational sound levels	4-55

Volume 2

Table	Title	Page
5-1	Thermal internal boundary layer depth after Raynor	5-13
5-2	Thermal internal boundary layer depth after Mitchell	5-13
5-3	Thermal internal boundary layer depth after Turner	5-14
5-4	Internal boundary layer depth after Plate	5-14
5-5	Internal boundary layer depth ranges	5-14
5-6	National and State of Florida ambient air quality standards applicable to the proposed site, Hillsborough County, Florida	5-15
5-7	Federal and State of Florida significance of impact levels for sulfur dioxide and particulate matter	5-16
5-8	Federal and State of Florida prevention of significant deterioration allowable increments	5-16
5-9	Air quality monitoring instrumentation	5-17
5-10	Air monitoring programs	5-18
5-11	TECO ambient monitoring network audits performed during the period 1976 through 1978	5-19
5-12	Summary of ambient 24-hour sulfur dioxide bubbler data in the vicinity of TECO Big Bend, 1976-1978	5-21
5-13	Summary of continuous sulfur dioxide monitoring data obtained in the vicinity of TECO Big Bend Powerplant	5-23
5-14	Frequency distribution of 3-hour average sulfur dioxide concentrations measured in the vicinity of TECO Big Bend Powerplant	5-24
5-15	Frequency distribution of 24-hour average sulfur dioxide concentrations measured in the vicinity of TECO Big Bend Powerplant	5-25
5-16	Summary of ambient 24-hour suspended particulate matter data in the vicinity of TECO Big Bend, 1976-1978	5-26
5-17	Summary of ambient 24-hour nitrogen dioxide bubbler data in the vicinity of TECO Big Bend, 1976-1978	5-28
5-18	Summary of ambient residual sound levels at Big Bend Station	5-29

LIST OF TABLES (Continued)

Table	Title	Page
5-19	Distribution of soils on the Big Bend site	5-60
5-20	Limitations, restrictions, hazards, engineering properties, and adverse factors of soils belonging to revised soil associations found at the Tampa Electric Company site	5-61
5-21	Summary of priority considerations by selected non-agricultural soil-use categories	5-63
5-22	Degree and kinds of limitations and suitability ratings for soil associations found at the Tampa Electric Company site	5-64
5-23	Vascular plants observed at Big Bend Station, March 1974 through May 1975	5-66
5-24	Vegetational analysis of Big Bend Station, First Quarterly Report, 1974	5-70
5-25	Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974	5-72
5-26	Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974	5-89
5-27	Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975	5-103
5-28	Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975	5-111
5-29	Checklist of species in Station 3A	5-121
5-30	Similarity index for study areas	5-123
5-31	Occurrence and numbers of amphibians and reptiles found in different habitats on the Big Bend site	5-124
5-32	Occurrence and numbers of amphibians and reptiles found in different habitats at Beacon Key, Florida	5-126
5-33	Summary of bird observations in different habitats on the Big Bend site	5-129
5-34	Birds observed in different habitats at Beacon Key, Florida	5-135
5-35	Mammals observed on the Big Bend site, 1972	5-139
5-36	Mammals trapped or sighted at the Big Bend site	5-140
5-37	Summary of small mammal data from Beacon Key	5-141
5-38	Important game species and furbearers whose geographic ranges include the Big Bend site	5-142
5-39	Extreme tides and high-water marks at Tampa, Florida	5-178
5-40	Jackson Branch and Newman Branch water-quality data	5-179
5-41	Water-quality data for Hillsborough Bay, Florida	5-180
5-42	Intake cooling-water quality at Big Bend Station	5-182
5-43	Summary of water-quality data for the Floridan aquifer	5-183
5-44	Water quality of site ground water and suggested EPA standards	5-184
5-45	Phytoplankton taxa reported from collections made at Big Bend from June 1972 to May 1974	5-185
5-46	Phytoplankton taxa reported from collections made at Big Bend from January 1976 to March 1977	5-188

LIST OF TABLES (Continued)

Table	Title	Page
5-47	The 20 most abundant phytoplankton taxa reported from collections made at Big Bend from January 1976 to March 1977	5-190
5-48	Benthic algae reported from collections made in Hillsborough Bay during 1958	5-190
5-49	Benthic algae reported from collections made at Big Bend from 1970 to 1973	5-191
5-50	Benthic marine algal and seagrass taxa reported from collections made at three sites in the embayment near the Big Bend Powerplant during 1975	5-191
5-51	Distribution and abundance of benthic seagrasses during surveys conducted at transects located in a control area and in areas near the Big Bend Powerplant during quarterly sampling in 1977 and 1978	5-192
5-52	Zooplankton taxa reported from collections made at Big Bend from 1970 to 1975	5-193
5-53	Relative abundance of ichthyoplankton taxa reported from collections made at Big Bend from January 1976 to March 1977	5-196
5-54	Relative abundance of invertebrate meroplankton taxa reported from collections made at Big Bend from January 1976 to March 1977	5-197
5-55	Select representative important species chosen for concentrated study during the aquatic ecology studies conducted at Big Bend during 1979-1980	5-200
5-56	Mean abundance of *Anchoa mitchilli* eggs and larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-201
5-57	Mean abundance of unidentified sciaenid eggs and larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-203
5-58	Mean abundance of *Bairdiella chrysoura* eggs and larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-205
5-59	Mean abundance of *Cynoscion* spp. eggs reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-207
5-60	Mean abundance of *Pogonias cromis* eggs and larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-208

LIST OF TABLES (Continued)

Table	Title	Page
5-61	Mean abundance of *Cynoscion nebulosus* larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-210
5-62	Mean abundance of *Harengula jaguana* eggs and larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-211
5-63	Mean abundance of *Menidia beryllina* larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-212
5-64	Abundance of non-RIS fish eggs reported from select meroplankton collections made in the intake canal of the Big Bend Powerplant from March to October 1979	5-213
5-65	Abundance of non-RIS fish larvae reported from select meroplankton collections made in the intake canal of the Big Bend Powerplant from March to October 1979	5-214
5-66	Mean abundance and relative composition of all RIS and non-RIS fish eggs reported from select meroplankton collections made in the intake canal of the Big Bend Powerplant from March to October 1979	5-216
5-67	Mean abundance and relative composition of all RIS and non-RIS fish larvae reported from select meroplankton collections made in the intake canal of the Big Bend Powerplant from March to October 1979	5-217
5-68	Mean abundance of *Menippe mercenaria* zoeal larvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-218
5-69	Mean abundance of *Penaeus duorarum* postlarvae reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980	5-219
5-70	Abundance of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal of the Big Bend Powerplant from March to October 1979	5-220
5-71	Mean abundance and relative composition of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal of the Big Bend Powerplant from March to October 1979	5-227

LIST OF TABLES (Continued)

Table	Title	Page
5-72	Molluscan taxa reported from collections made in Hillsborough Bay during August and September 1963	5-229
5-73	Relative abundance of the 25 most common organisms reported from seine collections made at Station SB-1 near Big Bend during 1973-1975	5-231
5-74	Relative abundance of the 25 most common organisms reported from seine collections made at Station SB-3 near Big Bend during 1973-1975	5-232
5-75	Relative abundance of the 25 most common organisms reported from trawl collections made on Transect TB-2 in the discharge canal of the Big Bend Powerplant during 1973-1975	5-233
5-76	Relative abundance of the 25 most common organisms reported from trawl collections made on Transect TB-3 near Big Bend during 1973-1975	5-234
5-77	Relative abundance of the 25 most common organisms reported from trawl collections made on Transect TB-4 near the Big Bend Powerplant during 1973-1975	5-235
5-78	Macroinvertebrate taxa reported from impingement studies conducted at the Big Bend Powerplant during 1972-1975	5-236
5-79	Total numbers of macroinvertebrates collected by trawl on seven transects near Big Bend from June 1976 to February 1977	5-237
5-80	Total numbers of macroinvertebrates collected by trawl on seven transects near Big Bend from June 1976 to February 1977	5-237
5-81	Seasonal occurrence of macroinvertebrate taxa reported from impingement collections made at the Big Bend Powerplant from January 1976 to March 1977	5-238
5-82	Abundance of RIS taxa reported from seine collections made at four stations near Big Bend from March 1979 to January 1980	5-239
5-83	Abundance of RIS taxa reported from trawl collections made at five stations near Big Bend from March 1979 to January 1980	5-241
5-84	Non-RIS macroinvertebrate taxa reported from Big Bend seine, trawl, and impingement collections made from March 1979 to February 1980	5-244
5-85	Benthic invertebrate taxa reported from collections made at Big Bend from February 1976 to February 1977	5-246
5-86	The nine most abundant benthic invertebrate taxa reported from collections made at Big Bend from February 1976 to February 1977	5-250
5-87	Benthic invertebrate taxa reported from collections made at Big Bend from May to December 1979	5-251
5-88	Temporal and spatial distribution of the dominant benthic invertebrate taxa collected at Big Bend from May to December 1979	5-253

LIST OF TABLES (Continued)

Table	Title	Page
5-89	Comparison of the temporal and spatial distribution of the dominant benthic invertebrates collected at comparable stations near Big Bend during 1979 and 1976	5-255
5-90	Relative abundance and density of *Nereis succinea* collected at stations near Big Bend from May to December 1979	5-256
5-91	Relative abundance and density of *Streblospio benedicti* collected at stations near Big Bend from May to December 1979	5-257
5-92	Relative abundance and density of *Mulinia lateralis* collected at stations near Big Bend from May to December 1979	5-258
5-93	Relative abundance and density of *Mediomastus californiensis* collected at stations near Big Bend from May to December 1979	5-259
5-94	Relative abundance and density of *Paraprionospio pinnata* collected at stations near Big Bend from May to December 1979	5-260
5-95	Relative abundance and density of *Pseudopolydora* sp. collected at stations near Big Bend from May to December 1979	5-261
5-96	Abundance data for benthic invertebrate collections made at stations near Big Bend from May to December 1979	5-262
5-97	Species richness data for benthic invertebrate collections made at stations near Big Bend from May to December 1979	5-263
5-98	Species diversity data on benthic invertebrate collections made at stations near Big Bend from May to December 1979	5-264
5-99	Equitability data on benthic invertebrate collections made at stations near Big Bend from May to December 1979	5-265
5-100	Clusters of stations near Big Bend with high similarity of benthic invertebrate assemblages from May to December 1979	5-266
5-101	Clusters of stations near Big Bend with moderate to high similarity of benthic invertebrate assemblages from May to December 1979	5-266
5-102	Mean abundance and percent coverage of oyster spat on ten replicate spat panels set at five stations near Big Bend at approximately 2-week intervals from March 1979 to January 1980	5-267
5-103	Seasonal occurrence of fishes reported from collections made at Big Bend from 1972 to 1975	5-268
5-104	Fish taxa reported from impingement studies conducted at the Big Bend Powerplant during 1972-1975	5-273

LIST OF TABLES (Continued)

Table	Title	Page
5-105	Summary data on the distribution of the fish taxa most commonly collected by seine at Big Bend from January 1976 to March 1977	5-274
5-106	Seasonal occurrence of fish taxa reported from impingement collections made at the Big Bend Powerplant from January 1976 to March 1977	5-275
5-107	Non-RIS fish taxa reported from Big Bend seine, trawl, and impingement collections made from March 1979 to February 1980	5-277
5-108	Whales and dolphins whose geographic ranges include coastal waters adjacent to or near the Big Bend site	5-281
5-109	Population of areas within 5 miles of the Big Bend site	5-328
5-110	Annual payroll of Hillsborough County by business sector	5-336
5-111	Number of employees in Hillsborough County by business sector	5-336
5-112	Hillsborough County area revenues, fiscal year ending September 30, 1978	5-337
5-113	Hillsborough County expenditures, fiscal year ending September 30, 1978	5-338
5-114	Total housing units, Hillsborough County	5-339
5-115	Summary of economic factors for the Tampa-St. Petersburg Standard Metropolitan Statistical Area, 1980-2020	5-339
5-116	Earnings projections for the Tampa-St. Petersburg Standard Metropolitan Statistical Area, 1980-2020	5-340
5-117	Hillsborough County water supply and demand	5-341
5-118	Hillsborough County school system revenue sources	5-342
5-119	Hillsborough County selected vegetable crops, 1975-1978	5-345
5-120	Hillsborough County agricultural statistics, 1969 and 1974	5-345
5-121	Parks and recreation areas near Big Bend	5-346
5-122	Archaeological sites within 5 miles of the Big Bend site	5-346
5-123	Total tonnage handled at the Port of Tampa, 1962-1978	5-355
5-124	Principal commodities of the Port of Tampa, past and projected	5-355
6-1	Vegetation selected for the conceptual site restoration at the Big Bend site	6-12
6-2	Average daily number of construction personnel required for Big Bend Unit 4	6-12
6-3	Plant PSD operating and pollutant emission parameters for Big Bend Units 1-4	6-78
6-4	FDER prevention of significant deterioration maximum increment consumption at the Big Bend site	6-79

LIST OF TABLES (Continued)

Table	Title	Page
6-5	EPA prevention of significant deterioration maximum increment consumption at the Big Bend site	6-80
6-6	Maximum air quality impacts at the Big Bend site with Unit 4 operating	6-81
6-7	Maximum air quality impacts for NO_2 and CO from Big Bend Unit 4	6-81
6-8	Worst days/periods utilized in PTMTPW computer model	6-82
6-9	Applicant's drift predictions and Class II PSD increments for a mechanical-draft cooling tower with saltwater makeup	6-83
6-10	Results of drift predictions for the mechanical-draft cooling tower	6-84
6-11	Summary of OFRAD salt drift modeling results, Big Bend Unit 4 mechanical-draft cooling tower	6-85
6-12	Predicted maximum monthly salt-deposition rates in nearby agricultural areas attributable to the operation of a mechanical-draft cooling-tower at Big Bend Unit 4	6-86
6-13	Engineering parameters input to the OFRAD model for estimating drift from a mechanical-draft cooling tower at Big Bend Unit 4	6-86
6-14	Continuous discharge stream water quality	6-87
6-15	Big Bend Station intake-water-quality data for three sampling periods	6-88
6-16	Big Bend Station intake-water-quality data, 1980-1981	6-89
6-17	Big Bend Unit 4 discharge-water quality following treatment to meet State and Federal effluent limitations	6-90
6-18	Big Bend Unit 4 discharge-water quality following treatment to meet State and Federal effluent limitations and reverse-osmosis treatment of the blowdown streams	6-91
6-19	Dilution factors calculated for chlorine discharge from Big Bend Unit 4	6-92
6-20	Tolerance of selected species to continuously chlorinated effuent	6-93
6-21	Flow, velocity, and temperature characteristics of the condenser-cooling-water systems for Big Bend Units 1-4	6-93
6-22	Water surface areas enclosed by ΔT isotherms during the combined operation of three Big Bend units without dilution pumps	6-94
6-23	Water surface areas swept over tidal cycle by ΔT isotherms during the combined operation of three Big Bend units without dilution pumps	6-94
6-24	Bottom contact data for thermal plume during the combined operation of three Big Bend units without dilution pumps	6-94

LIST OF TABLES (Continued)

Table	Title	Page
6-25	Water surface areas enclosed by ΔT isotherms during the combined operation of four Big Bend units without dilution pumps	6-95
6-26	Water surface areas swept over tidal cycle by ΔT isotherms during the combined operation of four Big Bend units without dilution pumps	6-95
6-27	Bottom contact data for thermal plume during combined operation of four Big Bend units without dilution pumps	6-95
6-28	Temperature of the effluent from Unit 4 at the outfall and of seasonal ambient water for the once-through-cooling alternative	6-96
6-29	Comparison of cooling-tower intake and discharge concentrations for potential sources of makeup water for Big Bend Unit 4	6-97
6-30	Comparison of water temperatures in cooling-tower intake and blowdown discharge for Big Bend Unit 4	6-98
6-31	Water-quality of site ground water and suggested EPA standards	6-99
6-32	Data on water quality of effluents produced at four different bottom-ash disposal areas	6-100
6-33	Numbers of fish and macroinvertebrates impinged in 24 hours on the traveling screens of the condenser cooling system at one generating unit of Big Bend Station, January 1976 to March 1977	6-101
6-34	Estimates of the numbers of fish and macroinvertebrates impinged on the traveling screens of the condenser cooling systems during continuous operation of Big Bend Units 1, 2, and 3 from January 1976 to March 1977	6-102
6-35	List of all representative important species collected from the traveling screens at the Big Bend Station between March 14, 1979, and February 12, 1980	6-103
6-36	Projections of the number of RIS fish and macroinvertebrate taxa impinged annually on the cooling-water traveling screens of Big Bend Units 1-3 and Units 1-4	6-105
6-37	Monthly RIS impingement estimates for four Big Bend units at 100 percent flow capacity	6-106
6-38	Operational data on condenser cooling water and dilution pumps for Big Bend Units 1-3, January 1976-March 1977	6-107
6-39	Estimated number of total fish eggs and larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of the Big Bend Station, January 1976-March 1977	6-108

LIST OF TABLES (Continued)

Table	Title	Page
6-40	Estimated number of total invertebrate meroplankton entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-109
6-41	Estimated entrainment of fish eggs, grouped by family, within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system at Big Bend Station, January-December 1976	6-110
6-42	Estimated entrainment of fish larvae, grouped by family, within the condenser cooling system of Units 1, 2, and 3 and the dilution pumping system at the Big Bend Station, January-December 1976	6-111
6-43	Estimated number of eggs and larvae of *Anchoa mitchilli* entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-112
6-44	Estimated number of eggs and larvae of Sciaenidae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-113
6-45	Estimated number of eggs and larvae of *Harengula jaguana* entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-114
6-46	Estimated number of *Pinnixa sayana* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-115
6-47	Estimated number of *Polyonyx gibbesi* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-116
6-48	Estimated number of *Upogebia affinis* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-117
6-49	Estimated number of *Neopanope texana* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-118
6-50	Estimated number of *Menippe mercenaria* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977	6-119
6-51	Monthly RIS entrainment estimates for four Big Bend units at 100 percent flow	6-120

LIST OF TABLES (Continued)

Table	Title	Page
6-52	Viability of fish eggs impinged on the prototype fine-mesh screen system at Big Bend Station, March-August 1980	6-121
6-53	Viability of fish larvae impinged on the prototype fine-mesh screen system at Big Bend Station, March-August 1980	6-122
6-54	Viability of the zoeal stages of various decapod crustacean macroinvertebrates impinged on the prototype fine-mesh screen at Big Bend Station, March-August 1980	6-122
6-55	Viability of the megalops stage of various decapod crustacean macroinvertebrates impinged on the prototype fine-mesh screen at Big Bend Station, March-August 1980	6-123
6-56	Analysis of variance in the survival of fish impinged on fine-mesh screens at Big Bend Station	6-124
6-57	Analysis of variance in the survival of invertebrates impinged on fine-mesh screens at Big Bend Station	6-125
6-58	Taxonomic groups recovered and identified in spray-wash efficiency sampling conducted at Big Bend Station during April-July 1980	6-126
6-59	Results of spray-wash efficiency testing conducted at Big Bend Station during April-July 1980	6-127
6-60	Taxonomic groups recovered and identified in screening efficiency sampling conducted at Big Bend Station	6-127
6-61	Results of screening efficiency testing at Big Bend Station	6-127
6-62	Taxonomic groups analyzed in flume and organism survival studies conducted at Big Bend Station from June through August 1980	6-128
6-63	Total 48-hour species survival in flume and organism survival studies at Big Bend Station, June-August 1980	6-128
6-64	Analysis of radionuclide content of coal, bottom ash, and fly ash from a western Kentucky coal	6-129
6-65	Average annual radionuclide emissions from a 417-MW powerplant firing different types of coal	6-129
6-66	Radiation doses to human organs from exposure to effluents from a 1,000-MW coal-fired powerplant and from natural background radiation	6-129
6-67	Relationship between severity of salt contamination and the potential for flashover on transmission lines	6-130
6-68	Projected worldwide CO_2 emissions, 1965-2000	6-191
6-69	Particulate production estimates	6-192
6-70	Mechanisms that convert sulfur dioxide to sulfates	6-196
6-71	Resources that would be committed to the proposed Big Bend Unit 4	6-197
6-72	Checklist of special status species	6-203

LIST OF FIGURES

Volume I

Figure	Title	Page
1-1	Tampa Electric Company service area	1-20
1-2	Historical and projected energy use, Tampa Electric Company	1-21
1-3	History and forecast of load and capacity additions for summer, Tampa Electric Company	1-22
1-4	History and forecast of load and capacity additions for winter, Tampa Electric Company	1-23
1-5	Peninsular Florida baseload unit delay sensitivity	1-24
1-6	Electricity demand forecasting technique employed by Tampa Electric Company	1-25
1-7	Total energy sales by Tampa Electric Company for period 1970-1988	1-26
1-8	Comparison of actual load profile and model results for January 1978 peak day, Tampa Electric Company	1-27
1-9	Comparison of actual load profile and model results for June 1978 peak day, Tampa Electric Company	1-28
1-10	Tampa Electric Company winter total system load for the period 1971-1988	1-29
2-1	Regional meteorological stations	2-11
2-2	Annual wind roses for Tampa and MacDill	2-12
2-3	Monthly wind roses for Tampa for the period 1971-1975	2-13
2-4	The Floridan Plateau	2-54
2-5	Regional geological map	2-55
2-6	Generalized stratigraphic section	2-56
2-7	Distribution of soil orders in Florida	2-57
2-8	Distribution and areal extent of submerged and emergent vegetation in the coastal zone of the Tampa Bay System	2-59
2-9	The Tampa Bay System and Big Bend Station	2-159
2-10	Total cadmium distribution in Tampa Bay, May 1973	2-160
2-11	Total copper distribution in Tampa Bay, May 1973	2-160
2-12	Total iron distribution in Tampa Bay, May 1973	2-161
2-13	Total lead distribution in Tampa Bay, October 1975	2-161
2-14	Total manganese distribution in Tampa Bay, October 1975	2-162
2-15	Total mercury distribution in Tampa Bay, October 1975	2-162
2-16	Total nickel distribution in Tampa Bay, May 1973	2-163
2-17	Total zinc distribution in Tampa Bay, October 1975	2-163
2-18	Well fields	2-164
2-19	Chemical, physical, and phytoplankton data, averaged for different regions of the Tampa Bay system in 1969-1970	2-165
2-20	Major highways and National Register historic sites in the Tampa Bay area	2-181
2-21	Aerial view of the TECO Big Bend 4 site showing vegetation cover types	2-218

LIST OF FIGURES (Continued)

Figure	Title	Page
3-1	Tampa Electric Company service area	3-25
3-2	Environmental composite	3-26
3-3	Map of preferred areas	3-27
3-4	Preferred sites relative to preferred areas	3-28
3-5	Once-through-condenser cooling system Units 1-3 at Big Bend Station	3-53
3-6	Existing screenwell arrangement for circulating-water-intake system at Big Bend Station Units 1-3	3-54
3-7	Once-through-with-dilution cooling system, Units 1-4 at Big Bend Station	3-55
3-8	Condenser cooling water flow path with mechanical-draft cooling tower	3-56
3-9	Limestone FGD system at Big Bend Station	3-57
3-10	Process flow diagram of the double-alkali FGD system alternative	3-58
3-11	Process flow diagram of the lime FGD system alternative	3-59
3-12	Process flow diagram of the Wellman-Lord FGD system (purge crystallization) alternative	3-60
4-1	General site location, Big Bend Station	4-2
4-2	Site and contiguous areas, Big Bend Station	4-3
4-3	Plot plan of Big Bend Station	4-4
4-4	Steam-generated electric power system, Big Bend Station	4-56
4-5	Plant water balance for the Big Bend Station	4-57
4-6	Detail of slag pond at Big Bend Station	4-59
4-7	Wastewater-treatment-pond irrigation systems at Big Bend Station	4-60
4-8	Coal-pile-runoff collection and treatment system, Big Bend Station	4-61
4-9	Flow diagram of the wastewater disposal/recycle system at Big Bend Station	4-62
4-10	Discharge structure at Big Bend Station	4-63
4-11	Dual flow fine-mesh screens, Units 3 and 4	4-64
4-12	Flow diagram of combustion system and air-pollution control system at Big Bend Station	4-65
4-13	Limestone flue-gas-desulfurization system at Big Bend Station	4-66
4-14	Conceptual design of the bottom-ash disposal pond and the fly-ash disposal pond, Big Bend Station	4-67
4-15	Bottom-ash, fly-ash, and flue-gas-desulfurization areas, Big Bend site	4-68
4-16	Heaped-fill configuration for storage of flue-gas-desulfurization by-product gypsum, Big Bend Station	4-69
4-17	Schematic of Big Bend coal-handling facilities and emission sources	4-70
4-18	SO_2 percentage reduction standard	4-71

LIST OF FIGURES (Continued)

Figure	Title	Page
	Volume 2	
5-1	The relationship between internal boundary layer and plume fumigation under onshore wind conditions	5-30
5-2	Characteristics of a typical sea breeze	5-31
5-3	Location of Big Bend site	5-32
5-4	Locations of SO_2 and TSP nonattainment areas in relation to Big Bend Station	5-33
5-5	Locations of TECO and Hillsborough County Environmental Protection Commission 24-hour ambient SO_2 bubbler monitoring stations within a 5-mile radius of Big Bend Station	5-34
5-6	Locations of TECO continuous ambient SO_2-monitoring stations within a 5-mile radius of Big Bend Station	5-35
5-7	Locations of TECO and Hillsborough County Environmental Protection Commission 24-hour ambient-TSP-monitoring stations within a 5-mile radius of Big Bend Station	5-36
5-8	Locations of TECO 24-hour ambient NO_2 bubbler monitoring stations within a 5-mile radius of Big Bend Station	5-37
5-9	Location of ambient-sound-level monitors at Big Bend Station	5-38
5-10	Subsurface profile of ash-disposal area of Big Bend Station	5-143
5-11	Locations of borings, well points, and test pits in the ash-disposal area at Big Bend Station	5-144
5-12	Boring location plan, Big Bend Station	5-145
5-13	Location of earthquake epicenters in relation to Big Bend Station	5-147
5-14	Soil resources of Big Bend Station	5-148
5-15	Vegetation cover types of Big Bend Station	5-149
5-16	The Tampa Bay System	5-282
5-17	Site and contiguous area	5-283
5-18	Phytoplankton sampling stations at Big Bend, January 1976-March 1977	5-284
5-19	Sites of collection of benthic macrophytes within the embayment near the Big Bend Powerplant during 1975	5-285
5-20	Benthic seagrass sampling transects near Big Bend, 1977-1978	5-286
5-21	Distribution of benthic seagrasses in a control area and in areas near the Big Bend Powerplant, 1977-1978	5-287
5-22	Meroplankton sampling stations at Big Bend, January 1976-March 1977	5-288
5-23	Seasonal occurrence of fish larvae in the Big Bend area during 1976-1977	5-289
5-24	Meroplankton sampling stations at Big Bend, February 1979-February 1980	5-290

LIST OF FIGURES (Continued)

Figure	Title	Page
5-25	Seasonal distribution of *Anchoa mitchilli* (bay anchovy) eggs and larvae in the Big Bend area during 1979-1980	5-291
5-26	Seasonal distribution of sciaenid eggs in the Big Bend area during 1979-1980	5-292
5-27	Seasonal distribution of *Bairdiella chrysoura* (silver perch) eggs and larvae in the Big Bend area during 1979-1980	5-293
5-28	Seasonal distribution of *Harengula jaguana* (scaled sardine) eggs and larvae in the Big Bend area during 1979-1980	5-294
5-29	Seasonal distribution of *Menippe mercenaria* (stone crab) zoeae in the Big Bend area during 1979-1980	5-295
5-30	Sites of collection of benthic mollusks in Hillsborough Bay during August-September 1963	5-296
5-31	Ecological zones in Hillsborough Bay based on the comparative diversity of benthic mollusks during August-September 1963	5-297
5-32	Benthic invertebrate sampling transects along the main ship channel in Tampa Bay, March-April 1973	5-298
5-33	Seine and trawl sampling stations at Big Bend, 1970-1975	5-299
5-34	Seine and trawl sampling stations at Big Bend, January 1976-March 1977	5-300
5-35	Seine and trawl sampling stations at Big Bend, March 1979-January 1980	5-301
5-36	Benthic invertebrate sampling stations at Big Bend, February 1976-February 1977	5-302
5-37	Benthic invertebrate sampling stations at Big Bend, May-December 1979	5-303
5-38	Seasonal variation of benthic faunal density at 13 stations near Big Bend during 1979	5-304
5-39	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at Stations 1, 2, and 3 in the area of the discharge canal of the Big Bend Powerplant during 1979	5-305
5-40	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at Stations 8 and 9 near Big Bend during 1979	5-306
5-41	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal Station 4 and nonthermal Station 10 near Big Bend during 1979	5-307

LIST OF FIGURES (Continued)

Figure	Title	Page
5-42	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal Station 5 and nonthermal Station 11 near Big Bend during 1979	5-308
5-43	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal Station 6 and nonthermal Station 12 near Big Bend during 1979	5-309
5-44	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal Station 7 and nonthermal Station 13 near Big Bend during 1979	5-310
5-45	Seasonal variation of mean bottom water temperatures at thermal Stations 4, 5, 6, and 7, nonthermal Stations 10, 11, 12, and 13, discharge canal Stations 1 and 2 and nearshore Stations 3, 8, and 9 near Big Bend during 1979	5-311
5-46	Spatial distribution of mean surface and bottom water temperatures at thermal Stations 4, 5, 6, and 7, nonthermal Stations 10, 11, 12, and 13, and discharge canal and nearshore Stations 1, 2, 3, 8, and 9 near Big Bend during 1979	5-312
5-47	Seasonal variation of mean bottom salinities at thermal Stations 4, 5, 6, and 7, nonthermal Stations 10, 11, 12, and 13, discharge canal Stations 1 and 2, and nearshore Stations 3, 8, and 9 near Big Bend during 1979	5-313
5-48	Seasonal variation of mean bottom dissolved oxygen concentrations at thermal Stations 4, 5, 6, and 7, nonthermal Stations 10, 11, 12, and 13, discharge canal Stations 1 and 2, and nearshore Stations 3, 8, and 9 near Big Bend during 1979	5-314
5-49	Comparison of the seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at Station 1 in the discharge canal of the Big Bend Powerplant during comparable sampling periods of 1976 and 1979	5-315
5-50	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at Station 2 in the discharge canal of the Big Bend Powerplant during comparable sampling periods of 1976 and 1979	5-316
5-51	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal transect Station 4 near Big Bend during comparable sampling periods of 1976 and 1979	5-317

LIST OF FIGURES (Continued)

Figure	Title	Page
5-52	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal transect Station 5 near Big Bend during comparable sampling periods of 1976 and 1979	5-318
5-53	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal transect Station 6 near Big Bend during comparable sampling periods of 1976 and 1979	5-319
5-54	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at thermal transect Station 7 near Big Bend during comparable sampling periods of 1976 and 1979	5-320
5-55	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at nonthermal transect Station 10 near Big Bend during comparable sampling periods of 1976 and 1979	5-321
5-56	Seasonal variation of benthic invertebrate species diversity, equitability, species richness, and faunal density at nonthermal transect Station 11 near Big Bend during comparable sampling periods of 1976 and 1979	5-322
5-57	Seasonal distribution of benthic invertebrate species diversity, equitability, species richness, and faunal density at nonthermal transect Station 12 near Big Bend during comparable sampling periods of 1976 and 1979	5-323
5-58	Seasonal distribution of benthic invertebrate species diversity, equitability, species richness, and faunal density at nonthermal transect Station 13 near Big Bend during comparable sampling periods of 1976 and 1979	5-324
5-59	Seasonal distribution of benthic invertebrate species diversity, equitability, species richness, and faunal density at nonthermal transect Station 14 near Big Bend during comparable sampling periods of 1976 and 1979	5-325
5-60	Oyster spat sampling stations at Big Bend, March 1979-January 1980	5-326
5-61	Towns within a 5-mile radius of Big Bend Station	5-329
5-62	New subdivisions, 1960-1970, in the vicinity of Big Bend Station	5-330
5-63	Net population growth pattern, 1960-1970, in the vicinity of Big Bend Station	5-331
5-64	Existing land use in the vicinity of Big Bend Station	5-347

LIST OF FIGURES (Continued)

Figure	Title	Page
5-65	Park, beach, wildlife, and conservation areas in the vicinity of Big Bend Station	5-348
5-66	Archaeological sites in the vicinity of Big Bend Station	5- 349
5-67	Hillsborough County generalized land-use map for year 2000	5-351
5-68	Artist's view of the Big Bend Station	5-357
6-1	Dredge-disposal areas, Big Bend site	6-13
6-2	Potentiometric surface map of the surficial aquifer, Big Bend Station	6-14
6-3	Five-year average wind rose for Tampa International Airport, 1971-1975	6-131
6-4	Baseline model of SO_2-increment-consuming sources at Big Bend	6-132
6-5	Baseline model of TSP-increment-consuming sources at Big Bend	6-133
6-6	Estimated 24-hour baseline SO_2 concentrations in the vicinity of Big Bend	6-134
6-7	Estimated 3-hour baseline SO_2 concentrations in the vicinity of Big Bend	6-135
6-8	Estimated 24-hour baseline TSP concentrations in the vicinity of Big Bend	6-136
6-9	Annual average baseline SO_2 concentrations in the vicinity of Big Bend	6-137
6-10	Annual average baseline TSP concentrations in the vicinity of Big Bend	6-138
6-11	Spatial annual SO_2 increment consumption in the Big Bend area	6-139
6-12	Spatial annual TSP increment consumption in the Big Bend area	6-140
6-13	Spatial 24-hour SO_2 increment consumption attributable to the Big Bend facility	6-141
6-14	Spatial 24-hour TSP increment consumption attributable to the Big Bend facility	6-142
6-15	Three-hour SO_2 PSD increment consumption at Big Bend	6-143
6-16	Annual SO_2 spatial increment consumption at Big Bend	6-144
6-17	Annual TSP spatial increment consumption at Big Bend	6-145
6-18	Projected annual SO_2 concentrations at the Big Bend site for all interacting emission sources	6-146
6-19	Projected annual TSP concentrations at the Big Bend site for all interacting emission sources	6-147
6-20	Projected 24-hour SO_2 concentrations attributable to the operation of Big Bend Units 1, 2, and 4 at 100 percent load	6-148
6-21	Projected 24-hour TSP concentrations attributable to the Big Bend facility	6-149

LIST OF FIGURES (Continued)

Figure	Title	Page
6-22	Projected 3-hour SO_2 concentrations attributable to the Big Bend facility	6-150
6-23	Annual average SO_2 concentrations resulting from the operation of Big Bend Unit 4 without Unit 3	6-151
6-24	Annual average TSP concentrations resulting from the operation of Big Bend Unit 4 without Unit 3	6-152
6-25	Maximum 24-hour SO_2 concentrations resulting from the operation of Big Bend Unit 4 without Unit 3	6-153
6-26	Maximum 24-hour TSP concentrations resulting from the operation of Big Bend Unit 4 without Unit 3	6-154
6-27	SO_2 incremental impacts of Big Bend Unit 4 at points of maximum impact and at nonattainment area boundaries	6-155
6-28	Percent frequency of potential ground fog resulting from operation of a mechanical-draft cooling tower at the Big Bend Powerplant	6-156
6-29	Annual salt-deposition rate predicted to result from operation of a mechanical-draft cooling tower at Big Bend Station	6-157
6-30	Liquid and gaseous emission points, Big Bend Station Unit 4	6-158
6-31	Isothermal contour map for three generating units operating at 100 percent load with no dilution pumps, Big Bend Station	6-159
6-32	Isothermal contour map for three generating units operating at 64 percent load with no dilution pumps, Big Bend Station	6-160
6-33	Isothermal contour map for four generating units operating at 100 percent load with no dilution pumps, Big Bend Station	6-161
6-34	Isothermal contour map for four generating units operating at 64 percent load with no dilution pumps, Big Bend Station	6-162
6-35	Location of potential sources of ground-water impact, Big Bend Station	6-163
6-36	Flow net of the wastewater pond, Big Bend Station	6-165
6-37	Standard length distribution of *Anchoa mitchilli* from January 1976 through March 1977	6-166
6-38	Standard length distribution of *Bairdiella chrysoura* from January 1976 through March 1977	6-167
6-39	Standard length distribution of *Lagodon rhomboides* from January 1976 through March 1977	6-168
6-40	Standard length distribution of *Cynoscion arenarius* from January 1976 through March 1977	6-169
6-41	Length distribution of *Penaeus duorarum* from January 1976 through March 1977	6-170
6-42	Standard length distribution of *Callinectes sapidus* from January 1976 through March 1977	6-171
6-43	Standard length distribution of *Limulus polyphemus* from January 1976 through March 1977	6-172

LIST OF FIGURES (Continued)

Figure	Title	Page
6-44	Standard length distribution of *Portunus gibbesi* from January 1976 through March 1977	6-173
6-45	Pen length distribution of *Lolliguncula brevis* from January 1976 through March 1977	6-174
6-46	Total length distribution of *Squilla empusa* from January 1976 through March 1977	6-175
6-47	Site plan, prototype fine-mesh screen, Big Bend Station Unit 4	6-176
6-48	Deck arrangement, prototype fine-mesh screen, Big Bend Station Unit 4	6-177
6-49	Profile arrangement, prototype fine-mesh screen, Big Bend Station Unit 4	6-178
6-50	Deck arrangement for fine-mesh screen test facility, prototype fine-mesh screen, Big Bend Station Unit 4	6-179
6-51	Alternative release locations, prototype fine-mesh screen, Big Bend Station Unit 4	6-180
6-52	Biological and water-quality sampling stations, prototype fine-mesh screen, Big Bend Station Unit 4	6-181
6-53	Dimensions of organism return canal	6-182
6-54	Disposal of organism after batch release at two locations in the organism return canal, Big Bend Station	6-183
6-55	Chemical changes occurring during photoirradiation of hydrocarbon-nitrogen oxide-air systems	6-193

Chapter 5

ENVIRONMENTAL SETTING OF PROPOSED PROJECT

5.1 ATMOSPHERE

5.1.1 CLIMATOLOGY AND METEOROLOGY

5.1.1.1 Meteorological Monitoring Programs

The air quality monitoring program at the site (in support of the prevention of significant air quality deterioration application) has not included meteorological monitoring. Because of the proximity of the Big Bend site to the first-class weather station at Tampa International Airport, onsite meteorological monitoring was not required to support atmospheric dispersion analyses. Presently, there are no plans to implement a meteorological monitoring program after Big Bend Unit 4 becomes operational.

5.1.1.2 Site Meteorology

In the absence of site-specific data from a monitoring program, site meteorological conditions can be characterized by summarized data available for Tampa International Airport from the National Climatic Center. These data have been discussed in Section 2.1.1.

5.1.1.3 Coastal Effects

Atmospheric dispersion and transport conditions can be significantly affected by coastal meteorological processes. Major considerations include modified dispersion due to offshore trajectories, coastal fumigation, and wind circulation patterns.

5.1.1.3.1 Offshore Dispersion

Frequent overwater trajectories of stack releases from Big Bend Unit 4 are expected because of the coastal location of the site and large-scale wind patterns. These offshore flows will be subject to more restrictive dispersion conditions than will overland flows, considering the laminar nature of air flow over the relatively smooth water surface and the occasional development of a water-surface-based inversion layer. For overwater trajectories of 7 miles, a 50 percent reduction in turbulence from overland values--as characterized by wind direction standard deviation (σ_θ) values--can be expected (Slade 1962; Van der Hoven 1967). When water temperatures are less than land temperatures (during spring and summer), the surface air layer is cooled from below, forming an inversion. This inversion begins forming at the surface near the shoreline and develops vertically to approximately 50 meters at about 4 miles offshore (Prophet 1961). The overall result is that, on the average, the expected plume concentrations for low-level releases are about 50 percent higher for overwater than for overland trajectories, even though the wind speed of overwater flows is normally 25 percent higher than that of overland flows (Van der Hoven 1967; Slade 1962).

5.1.1.3.2 Coastal Fumigation

Coastal fumigation is associated with the transition from overwater to overland dispersion conditions. During an onshore flow, the atmospheric turbulence may be increased because of a rough, heated land surface. Although a shoreline surface release might be contained in the modified air (internal boundary layer) and dispersed as if the air were always over land, an elevated shoreline release would probably be above the modified air, and would thus initially disperse as if the air were always over water. At some distance downwind from the shoreline, however, the depth of the internal boundary layer should increase so as eventually to envelop the trajectory from an elevated release. This intersection results in vigorous vertical mixing, which significantly lowers the plume and produces relatively high ground-level concentrations that can persist for hours (Figure 5-1; Gutfreund, undated; Hsu 1976; Collins 1971). There have been limited field measurements that tend to confirm the potential for coastal fumigation in the site region (Marks 1978).

The increasing depth of the modified onshore flow is affected by surface heating and surface roughness. Prophet (1961) showed in his studies over Nantucket Island that the rate of increase in depth will also be influenced by the degree of thermal stability (ΔT) of the overwater air; under more stable conditions, the depth of the modified air will increase less rapidly.

Lyons and Olsson (1973) have described the slope of the turbulence layer for stable onshore flow off the Great Lakes. Recently, Raynor et al. (1974) at Brookhaven National Laboratory conducted coastal diffusion studies. From their results and a review of previous work by others, they developed an empirical formula for describing the depth (H) of the thermal internal boundary layer (TIBL) resulting from land/sea-surface temperature differences in onshore/offshore flows:

$$H = \frac{u^*}{\bar{u}} \left[\frac{F(|\theta_1 - \theta_2|)}{|\partial T/\partial Z|} \right]^{1/2} \qquad (5\text{-}1)$$

where

$\frac{\partial T}{\partial Z}$ = vertical temperature gradient over source region (°C/m)

θ_1 = temperature in source region (°C)

θ_2 = temperature in downwind region (°C)

F = fetch, distance over downwind surface (m)

u^* = friction velocity in downwind region (m/s)

$\bar{u}$ = wind speed in downwind region (m/s)

Martin et al. (1976) pointed out that this relationship is better than other formulations for instances of offshore flow onto a cool water surface. Mitchell (1975) showed that the application of the Brookhaven formula is valid for stable onshore flow to warm land, with the modification (Equation 5-2) that $\partial T/\partial Z$ be defined as the absolute value of the difference between the vertical temperature gradient over the source region and that in the TIBL of the downwind region:

$$H = \frac{u^*}{\bar{u}} \left[\frac{F(|\theta_1 - \theta_2|)^{1/2}}{|(\Delta T/\Delta Z)_1 - (\Delta T/\Delta Z)_2|} \right] \qquad (5\text{-}2)$$

where $(\Delta T/\Delta Z)_1$ is the vertical temperature gradient (°C/m) over the water (for this application), and $(\Delta T/\Delta Z)_2$ is the vertical temperature gradient (°C/m) in the TIBL.

Equation 5-2 was used to estimate TIBL heights for the Big Bend 4 site region. It was assumed that u^*/u was approximately 0.1 (Sutton 1953; Mitchell 1975). For purposes of evaluation under stable onshore flow during daytime heating, a range of inversions was assumed from near +0.1°C/100 m (isothermal) to +0.5°C/100 m. In addition, $|\theta_1 - \theta_2|$ ranges of about 2° to 6°C were used. These ranges were based on the difference between applicable monthly mean sea-surface temperatures (Naval Weather Service Command 1974) and Tampa mean maximum temperature data (National Climatic Center 1979).

Table 5-1 presents approximate depths of the TIBL at inland distances of 500, 750, 1000, and 1500 meters determined using Equation 5-1. TIBL values were also obtained using the modification by Mitchell (Equation 5-2) and assuming a downwind region characterized by very unstable atmospheric conditions (-2.0°C/100 m). The results for the same distances are presented in Table 5-2.

Another estimate of the depth of the TIBL was made employing the approximation that Hewson adopted from Turner (1970) for use in making dispersion estimates. The extent of vertical growth h, in meters, of the modified air into an inversion is expressed as follows:

$$h = (4tk)^{1/2} \qquad (5\text{-}3)$$

where t is time (seconds) as determined by inland distance (meters) divided by wind speed (m/s), and k is eddy diffusivity, which is based on the value 3 m^2/s suggested by Hunson (Turner 1970).

The resulting depth values for Equation 5-3 are presented in Table 5-3 for representative wind speeds. Note that the temperature gradient is unspecified for this inversion calculation and that no particular land/sea-surface temperature difference is taken into account.

There are many instances when temperature differences over land and sea are minimal. This is especially true during onshore flow at night or on cloudy days. Under such conditions, only the change in roughness from sea to land would cause a growth of the internal boundary layer.

The depth D, in meters, of the internal boundary layer resulting from a roughness change can be approximated using Elliot's method (Plate 1971):

$$D = a\left(\frac{X}{Z'}\right)^{0.8}\left(Z'_0\right) \qquad (5\text{-}4)$$

where a varies as follows:

$$a = 0.75 - 0.03\ \ln\left(\frac{Z'_0}{Z_0}\right) \qquad (5\text{-}5)$$

Here the variables Z_0 and Z_0' are the roughness length of the source and downwind regions, respectively, and X is the downwind distance of interest in meters. On the basis of Plate's (1971) presentation of Davenport's work, the roughness lengths of the sea-surface source and of the near-shore region can be estimated as 10^{-3} and 1 meter, respectively. The resulting approximations of internal boundary layer depths based on Equations 5-4 and 5-5 are presented in Table 5-4. A summary of the range of TIBL estimates based on Tables 5-1 through 5-4 is presented in Table 5-5.

5.1.1.3.3 Coastal Wind Circulation Patterns

A major consideration in assessing the impact of coastal wind circulation patterns on the atmospheric dispersion and transport of shoreline powerplant stack plumes is the distinction between large-scale and mesoscale wind flows and the orientation of winds relevant to the shoreline.

5.1.1.3.3.1 Gradient Offshore Flows

The predominant large-scale wind flow at the site region is toward Tampa Bay and the Gulf of Mexico (i.e., offshore). As discussed in Section 2.1.1, seasonal variations are significant, with offshore winds occurring more frequently during the fall. These offshore wind flows transport powerplant stack releases out over Tampa Bay; there is, therefore, the possibility of restrictive dispersion conditions over water and coastal fumigation on the western shoreline of the bay.

5.1.1.3.3.2 Gradient Onshore Flows

Large-scale (synoptic) wind patterns resulting in onshore wind flows are infrequent in the site region. Generally during the warmer months, mesoscale "sea breeze" circulations will form during large-scale offshore and onshore wind flows (Marks 1978). The environmental impact of large-scale onshore wind patterns is influenced by the density of the population near the coast as well as the potential for prolonged coastal fumigation.

5.1.1.3.3.3 Sea Breezes

A sea breeze (mesoscale) circulation develops during weak, large-scale wind conditions if the water temperature is less than the land temperature. This is a diurnal as well as seasonal phenomenon (Hendrickson et al. 1976; Sonu 1973; Munn 1966). These temperature differences are at a maximum during the late morning and afternoon hours of the spring and summer in the site region (Pielke 1973). Sea breeze circulation is produced when warm air rises over the land and is replaced by a low-level, onshore flow of air, and a compensating offshore flow aloft is subsequently established (Marks 1978). The sea breeze wind system, therefore, approximates a closed circulation, and the potential exists for pollutants to travel through the cycle several times. However, the recirculation flow is generally not stationary; trajectories may approximate a helix and, therefore, additional pollutant buildups would not necessarily occur (Gutfreund, undated).

The wind speed in a sea breeze is generally on the order of 5 m/s, but speeds of up to 10 m/s can occur (Sonu 1973). Because of the coriolis effect, sea breeze winds rotate clockwise as a function of time during their development and, therefore, mature circulations have a component parallel to the shoreline during late afternoon (Sonu 1973; Munn 1966). Sea breezes in Florida frequently extend inland several miles and occasionally 20-30 miles from the shoreline (Environmental Research and

Technology, Inc. 1978). The onshore flow layer of the sea breeze is approximately 500 meters thick and the return layer aloft is about 1,000 meters thick, but offshore wind speeds are about half the onshore values. Convergence occurs onshore in a zone about 1-2 kilometers wide. Subsidence above the sea breeze circulation can result in reduced mixing heights. The characteristics of a sea breeze are illustrated in Figure 5-2 (Lyons 1975).

Sea breeze circulations increase the frequency of onshore low-level trajectories and hence the potential for coastal fumigation. However, buoyant releases from tall stacks located at the shoreline may penetrate the low-level onshore flow of the sea breeze and be transported offshore within the return flow (Lyons 1975).

5.1.1.3.3.4 Land Breezes

Land breezes are mesoscale circulations that are the converse of sea breezes. These low-level offshore wind flows develop during weak, large-scale wind patterns if the water temperature is greater than the land temperature (i.e., generally during fall and winter nights). Land breezes occur less frequently than sea breezes and are relatively weaker wind systems (Munn 1966). The return circulation aloft is onshore. The low-level offshore flow layer is rather shallow (200 meters) and seldom exceeds a seaward range of 50 kilometers from the shore. Distances of 3-15 kilometers are typical (Sonu 1973; Lyons 1975; Olsson, Cole, and Hanson 1968). A convergence zone may form over the water and become a region of pollutant accumulation, and these pollutants may be recycled in the system. This front can be advected to shore as a sea breeze system becomes established.

5.1.2 AMBIENT AIR QUALITY

5.1.2.1 Ambient Air Quality Standards and Prevention of Significant Deterioration Increments

National and State of Florida ambient air quality standards (AAQS) are presented in Table 5-6. In general, Florida AAQS are identical to national secondary AAQS, with the exception of annual and 24-hour sulfur dioxide (SO_2) and 1-hour ozone (O_3) standards. No national secondary SO_2 standards exist for annual and 24-hour time periods, and the Florida 1-hour O_3 standard is approximately 33 percent more stringent than the national secondary 1-hour O_3 standard. Primary standards define pollutant limits judged necessary to protect public health with an adequate margin of safety. Secondary standards define pollutant limits judged necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

The Big Bend site is located in the West-Central Intrastate Air Quality Control Region (AQCR). Portions of this AQCR are classified as nonattaining (measured violation of NAAQS) for SO_2, total suspended particulates (TSP), and O_3. The remaining portion of the AQCR includes areas classified as better than the national average for all criteria pollutants and areas that cannot be classified for such pollutants.

Figure 5-3 shows the location of the Big Bend site and Figure 5-4 shows the locations of the SO_2 and TSP nonattainment areas in relation to the Big Bend site. Hillsborough and Pinellas counties, which are located in the West-Central Intrastate AQCR, have been designated nonattaining for O_3. As promulgated by U.S. Environmental Protection Agency (EPA) and State of Florida regulations, it must be demonstrated that emissions from the proposed source will not exceed "significance of impact levels" for SO_2 and TSP pollutants within the applicable nonattainment areas. The "significance of impact levels" for nonattainment areas are presented in Table 5-7.

For the prevention of significant deterioration (PSD) of ambient air quality, the EPA enacted regulations on December 5, 1974, amended in August 1977 (40 CFR 52), limiting increases in SO_2 and TSP from major new or modified emission sources, depending on the priority classification of the area. The allowable increases are smallest in Class I areas and largest in Class III areas. Table 5-8 presents the allowable PSD class increments. Hillsborough and surrounding counties are designated Class II areas. The closest Class I area is the Chassahowitzka National Wildlife Refuge approximately 92 kilometers north of the proposed site.

Federal PSD regulations require an analysis of ambient air monitoring data as part of the PSD review process. This analysis must be conducted for all PSD pollutants. For a coal-fired steam electric power generating unit such as the proposed new source, the pollutants SO_2, TSP, nitrogen oxides (NO_x), and carbon monoxide (CO) must be analyzed. Ambient air monitoring historically has not been required for CO because powerplants do not contribute significantly to ground-level CO concentrations.

5.1.2.2 Methodology of Ambient Air Monitoring

There are two sources of ambient air quality data: the Hillsborough County Environmental Protection Commission (HCEPC) and the Applicant's monitoring networks. The sampling program consists primarily of eight noncontinuous and five continuous SO_2 monitors, seven high-volume TSP sampling stations, and seven NO_2 monitors. Table 5-9 lists the various monitoring sponsors, frequencies of measurement, data collection periods, and elevations.

Special aspects of the operation of the continuous SO_2-monitoring program should be noted. Continuous SO_2 monitors in the vicinity of the Big Bend site have historically been operated by both the Applicant and HCEPC. The Applicant's monitors were initially installed, operated, and monitored by Environmental Science and Engineering, Inc. (ESE) as part of a joint venture between the Applicant, ESE, and Environmental Research and Technology, Inc. (ERT). After July 30, 1978, the monitoring network was operated by the Applicant's Central Testing Laboratory.

5.1.2.2.1 Sampling Methods

Sampling methods utilized in the Applicant's monitoring network are presented in this section. Included for discussion are SO_2, TSP, and NO_2 sampling methods.

Table 5-10 presents data on air-monitoring programs both for stack emissions from Big Bend Units 1-3 and for the ambient air.

5.1.2.2.1.1 Sulfur Dioxide (Noncontinuous)

SO_2 sampling is conducted at all of the Applicant's stations using procedures consistent with the EPA reference method (pararosaniline method; 40 CFR 50.11, Appendix A, July 1, 1976) involves absorption of SO_2 in a 0.04-mole solution of potassium tetrachloromercurate, forming a stable dichlorosulfitomercurate complex.

Pararosaniline methyl sulfonic acid is formed by the reaction between the dichlorosulfitomercurate complex, pararosaniline, and formaldehyde. The concentration of pararosaniline methyl sulfonic acid is subsequently determined spectrophotometrically.

The effects of the principal known interferences are minimized or eliminated. Interferences by NO_x are eliminated by sulfamic acid and interferences by heavy metals are eliminated by ethylenediaminetetraacetic acid (EDTA) and phosphoric acid. After sample collection, the solutions are relatively stable; however, recent studies show that temperatures above 22°C cause high losses of SO_2 (Fuerst, Scarengelli, and Margeson 1976). The presence of EDTA enhances the stability of SO_2. Samples stored at 5°C suffer no detectable losses of SO_2. The rate of decay is independent of the concentrations of SO_2.

Beginning in July 1976, all Applicant and HCEPC SO_2 bubblers were equipped with temperature control devices, and constant-temperature containers were utilized to store and ship samples. The Applicant's temperature-controlled samplers were equipped with constant-recording thermometers to verify that sampling was conducted within the temperature ranges specified by the EPA. These specifications require that samples be collected at 25°C (77°F) or less and maintained at 20°C (68°F) or less until analysis.

Considerable research by the EPA has been directed toward evaluation of the method. Resulting modifications (36 FR, 1972) indicate that the absorption efficiency is greater than 98 percent for SO_2 concentrations greater than 25 g/m^3 within a certain temperature range.

5.1.2.2.1.2 Sulfur Dioxide (Continuous)

The Applicant's continuous SO_2 monitors are Thermo Electron Model 43 pulsed fluorescent analyzers. The pulsed fluorescent monitoring procedure involves the transmission of pulsating ultraviolet light through the sample gas that is contained in a fluorescent chamber. The ultraviolet radiation excites SO_2 molecules, which give off a characteristic decay radiation. A photomultiplier tube detects the magnitude of energy release and converts the reading into a voltage that is in direct proportion to the concentration of SO_2 in the sample stream.

The Thermo Electron analyzers have been complemented by ancillary equipment designed to ensure accurate data collection. This equipment includes chart recorders and several calibration systems. A complete description of the Applicant's monitoring system, including quality assurance, operation, maintenance, and calibration procedures, can be found in two documents developed by ERT and submitted to EPA Region IV and the Florida Department of Environmental Regulations. These documents are entitled "Big Bend Monitoring Networks Quality Assurance Manual" (December 1976) and "Big Bend Monitoring Network Operations, Service and Maintenance Manual" (December 1976).

The Thermo Electron Model 43 analyzer operating in the 0-0.5 part per million (ppm) range has been designated as an equivalent method by the EPA (41 FR 40, February 27, 1976). The analyzers at several of the Applicant's stations are operated in the 0-1 ppm range. The manufacturer has recently submitted to the EPA the necessary documentation and has received equivalency approval on the 0-1 ppm range (44 FR 72, April 12, 1979).

5.1.2.2.1.3 Total Suspended Particulates

The procedure used for collection of TSP samples is the Federal reference method (40 CFR 50, Appendix B). Air is drawn into a covered housing and through a glass fiber filter by means of a high-flow-rate blower. The flow rate is 40-60 ft^3/min. Suspended particles are collected on the filter surface. The mass concentration ($\mu g/m^3$) of the suspended particulate matter in the ambient air is computed by measuring the mass of collected particles and the volume of air sampled.

The only interferences of the method are contaminants that would block the filter and cause air flow to drop rapidly at a nonuniform rate. Glass filters are comparatively insensitive to changes in relative humidity.

5.1.2.2.1.4 Nitrogen Dioxide

During the sampling period, the sodium arsenite method for the determination of NO_2 in the atmosphere was utilized for all NO_2 samples collected by the Applicant's network. This method has been designated as an equivalent sampling method (42 FR 62,971, December 14, 1977). The method involves the adsorption of NO_2 in a sodium hydroxide-sodium arsenite solution and spectrophotometric analysis of the resulting nitrite ion.

5.1.2.2.2 Quality Assurance

As described previously, all of the Applicant's monitoring stations are operated according to the promulgated Federal reference methods. Monitoring sites were located and evaluated for proper siting criteria by use of an ERT-developed computer program. This program incorporated recommended criteria and guidelines for siting both continuous and noncontinuous monitors.

As an additional measure to ensure valid data collection, the Applicant had independent audits performed by environmental consulting firms during the period 1976 through 1978. Audits were performed on both the continuous and noncontinuous monitoring stations. These audits consisted of review of field procedures, inspection of monitoring sites and equipment, and operational checks of flow rates, pumps, orifices, etc. In addition, the Applicant's laboratories were audited periodically to ensure proper data analysis and calculation.

Table 5-11 summarizes the audits which the Applicant and its consultants performed on the three ambient-air-monitoring networks (SO_2, TSP, and NO_2) during the data collection period. The table also shows the individuals involved in the audits and the dates the audits were performed.

5.1.2.3 Baseline Ambient Air Quality: Data Analysis

This section presents an analysis of available ambient-air-monitoring data in the vicinity of Big Bend for SO_2, TSP, and NO_2. The data span a 3-year period in which both continuous and noncontinuous data were obtained. A review of quality assurance procedures for Applicant-operated monitors was presented in Section 5.1.2.2.2.

5.1.2.3.1 Sulfur Dioxide

5.1.2.3.1.1 Noncontinuous Data

Locations of 24-hour SO_2 bubbler air-monitoring stations in the vicinity of the Big Bend powerplant are shown in Figure 5-5. SO_2 data are available for the 1976-1978 period from both the HCEPC and Applicant air-monitoring networks (Table 5-12). Beginning in July 1976, the samples collected by both the Applicant and HCEPC were temperature-controlled during sampling and storage.

Eight monitoring stations are located within approximately a 5-mile radius of Big Bend. The maximum 24-hour SO_2 concentration recorded at any station was 293 $\mu g/m^3$, occurring during 1977 at HCEPC Station 54.

The second highest values at Station 54 were well below the AAQS level of 260 $\mu g/m^3$; therefore, no violations of AAQS were recorded. Station 54 was not in operation in 1978; it was colocated with Applicant Station 5, however, and Station 5 was in operation in 1978.

Other SO_2-monitoring stations did not exceed the 24-hour or annual AAQS. Maximum 24-hour concentrations at these stations were less than 60 percent of the State of Florida standard of 260 $\mu g/m^3$. Annual arithmetic mean concentrations at any station were less than 40 percent of the State of Florida AAQS.

5.1.2.3.1.2 Continuous Data

In early 1977, the Applicant started a continuous ambient-SO_2-monitoring program in the vicinity of Big Bend as part of a special SO_2 study. Figure 5-6 shows the locations of the five monitoring stations utilized in the special study.

Table 5-13 presents the results of the monitoring program, including the number of 3-hour and 24-hour observations and the percent data recovery at each station during the monitoring period, the arithmetic mean concentration, and the highest 3-hour and 24-hour measured concentrations ($\mu g/m^3$). Two values are shown for the 3-hour and 24-hour (i.e., short-term) averaging times—a nonoverlapping (NOL) or consecutive period maximum average and a running (RUN) maximum average.

As shown in Table 5-13, maximum and arithmetic mean SO_2 concentrations did not approach any applicable air quality standard except at Station T4, Bullfrog Creek. At T4, the maximum 3-hour and 24-hour values, representing about 90 percent of the respective 3-hour and 24-hour standards, occurred on May 7, 1977. The maximum 1-hour concentration during the period was estimated at 0.650 ppm, or 1,690 $\mu g/m^3$. Because the continuous analyzer was set on the 0 to 0.5 ppm (1,300 $\mu g/m^3$) scale during this period, the highest 1-hour concentrations were determined by estimation. The applicable short-term averaging time standards can be exceeded once per year. The second highest recorded concentrations at T4 were well below the air quality standards. Maximum measured short-term concentrations at stations other than T4 did not exceed about 80 percent of the air quality standards. Annual arithmetic mean concentrations did not exceed 30 percent of the applicable standard.

Tables 5-14 and 5-15 present frequency distributions of nonoverlapping 3-hour and 24-hour averages, respectively, based on data obtained in the continuous monitoring program. Upper limits of each frequency interval are shown in both ppm and $\mu g/m^3$. Two distributions are presented for each station, denoted by the columns marked

"I" and "II." Column I gives the frequency of occurrence of concentrations within each interval, and Column II gives the cumulative frequency of occurrence up to and including the specified interval.

The frequency distribution data show a marked skew towards the lower concentrations, both for the 3-hour and for the 24-hour averaging times. More than 80 percent of the observations at all monitoring stations fall below 0.01 ppm (26 $\mu g/m^3$). One 3-hour and one 24-hour observation, both occurring on May 7, 1977, fell within the interval containing the State of Florida AAQS of 1,300 and 260 $\mu g/m^3$, respectively. These observations reflect the only time that these standards were approached during the monitoring period.

5.1.2.3.2 Total Suspended Particulates

TSP data obtained in the vicinity of Big Bend are summarized in Table 5-16. The Federal reference method for TSP was used to obtain these values on a once-every-sixth-day sampling schedule. Locations of the ambient monitors of both HCEPC and the Applicant are shown in Figure 5-7.

TSP data are available from seven stations for the 1976-1978 period. Two of these stations, Applicant Station 5 and HCEPC Station 54, were colocated during this period. The maximum 24-hour TSP concentration recorded at any station during the sampling period was 143 $\mu g/m^3$ at Applicant Station 5 in 1976. This value represents 95 percent of the Florida 24-hour AAQS of 150 $\mu g/m^3$. The second highest 24-hour concentration at Applicant Station 5 was 71 $\mu g/m^3$, which is less than half of the standard.

During 1977 and 1978, the maximum measured 24-hour TSP concentration at any station was 115 $\mu g/m^3$, which occurred at Applicant Station 6. This value is approximately 75 percent of the AAQS. The data show that all TSP stations within 5 miles of Big Bend are in compliance with short-term TSP AAQS.

The annual geometric mean AAQS for the State of Florida is 60 $\mu g/m^3$. The highest geometric mean calculated for data collected in the study area was 41 $\mu g/m^3$ (68 percent of the standard), which occurred at Applicant Station 5 in 1976. Since that time, annual geometric means have not exceeded 40 $\mu g/m^3$ at any sampling station and are representative of rural background TSP levels.

5.1.2.3.3 Nitrogen Dioxide

NO_2 data from the Big Bend area are available from seven Applicant stations for the 1976-1978 period (Figure 5-8). All samples were collected generally on a once-every-third-day schedule utilizing 24-hour bubblers and the sodium arsenite Federal reference method for NO_2. Maximum 24-hour concentrations at any station did not exceed 221 $\mu g/m^3$ (Table 5-17). Only an annual arithmetic mean AAQS exists for NO_2, and it is 100 $\mu g/m^3$. The maximum annual arithmetic mean concentration recorded for any station was 38 $\mu g/m^3$ at Applicant Station 17 during 1978. This value represents 38 percent of the annual standard.

5.1.3 AMBIENT NOISE

The total noise at any location is composed of sounds from many sources, both local and distant. In the vicinity of the Big Bend Station, there are many sources of ambient noise. These include the Mineral Aggregates, Inc. plant located east of the site, traffic on U. S. Highway 41, local traffic, commercial and military aircraft, distant railroad traffic, and the natural sounds of insects, rustling leaves, birds, and surf.

To provide a basis for noise impact assessment, the noise level in the vicinity of the Big Bend Station was determined by means of two ambient-sound-level surveys. Each survey consisted of three daytime and three nighttime sets of measurements. The first survey, with Units 1 and 2 operating, was conducted in February 1974 to quantify and characterize the existing ambient sound levels. The second survey was conducted in January 1978 to determine whether the operation of Unit 3 and new residential development in the Apollo Beach area had significantly changed the ambient levels.

Measurements were made on the plant site at three locations approximately 1,000 feet from the station center in three directions to determine reliably the sound energy emanating from the plant. Measurements were also made at five offsite locations in populated and open areas of the surrounding community. The resulting values were used to quantify the existing ambient sound levels and to determine the dominant noise sources. The measurement locations are shown on Figure 5-9.

A-weighted sound-level and octave-band sound-pressure-level measurements were made with a Type 1 precision sound-level meter with attached octave-band filter set during both surveys. A pistonphone was used to calibrate the microphone and the sound-level meter. During lulls in the identifiable transient noises, either the minimum or average sound levels were measured, depending on whether the measurement location was in the community or on the plant site, respectively.

During the noise measurements, the Big Bend Station units were generally operating on 175-350 megawatts, except that Unit 2 was not operating on the night of January 17, 1978. The Big Bend Station gas turbines were not operating during any of the measurements. The measurements from the two surveys are presented in Table 5-18.

The sound levels measured at locations 1, 2, and 3 are considered typical of the average noise of Units 1 and 2 (1974 data) and Units 1, 2, and 3 (1978 data). The average of all 1974 data at positions 1, 2, and 3 is 58 decibels on the A weighting curve (dBA). The average of the corresponding 1978 data is 61 dBA, indicating an average 3 dBA increase due to the operation of Unit 3.

At the more distant measurement locations, the plant was sometimes audible, depending on weather conditions as well as the prevalence of masking noise. The degree of plant audibility during each measurement is also noted in Table 5-18. The actual sound levels at locations 4 through 8 did not always include a significant plant contribution. Local traffic and traffic on nearby U.S. Highway 41 were often the dominant sources of audible noise measured at locations 4, 5, and 6 and sometimes at locations 7 and 8. Sound-level measurements were made during lulls in traffic. However, distant traffic noise was relatively constant and was part of the ambient noise.

The data show that the averages of the 1978 nighttime sound levels at each measurement position were within 3 dBA of the corresponding 1974 averages, except at location 5, where an 8-dBA increase occurred because of the noise from the Mineral Aggregates, Inc., facility. It can be concluded, therefore, that the current nighttime ambient levels are very similar to the 1974 levels. However, the 1978 daytime averages range from 2 to 12 dBA above the 1974 values. Although a small part of the increase may be due to the operation of Unit 3, most of it is due to higher levels of daytime activity and local traffic associated with increased residential development.

The data also show that the plant is not the predominant source of residual offsite noise, even with Units 1, 2, and 3 operating. The highest residual sound level measured at the offsite locations was 56 dBA at location 5, when sound from the Big Bend Station was not audible. The lowest sound level measured was 31 dBA at location 7, with only distant traffic audible. It is clear, then, that although the station contributes to ambient noise, there are several other major community noise sources.

Table 5-1. Thermal internal boundary layer depth after Raynor (Equation 5-1)

Inland fetch (m)	Layer depth (m)	
	$\theta_1-\theta_2 = 2^{\circ}C$	$\theta_1-\theta_2 = 6^{\circ}C$
	$\partial T/\partial Z = +0.1^{\circ}C/100$ m	
500	100	173
750	122	212
1,000	141	245
1,500	173	300
	$\partial T/\partial Z = +0.5^{\circ}C/100$ m	
500	45	77
750	55	95
1,000	63	110
1,500	77	134

Table 5-2. Thermal internal boundary layer depth after Mitchell (Equation 5-2)

Inland fetch (m)	Layer depth (m)	
	$\theta_1-\theta_2 = 2^{\circ}C$	$\theta_1-\theta_2 = 6^{\circ}C$
	$(\Delta T/\Delta Z)_1 = +0.1^{\circ}C/100$ m; $(\Delta T/\Delta Z)_2 = -2.0^{\circ}C/100$ m	
500	22	38
750	27	46
1,000	31	53
1,500	38	65
	$(\Delta T/\Delta Z)_1 = +0.5^{\circ}C/100$ m; $(\Delta T/\Delta Z)_2 = -2.0^{\circ}C/100$ m	
500	20	35
750	24	42
1,000	28	49
1,500	35	60

Table 5-3. Thermal internal boundary layer depth after Turner (1970; Equation 5-3)

Inland fetch (m)	Layer depth (m)	
	u = 3 m/s	u = 6 m/s
500	45	32
750	55	39
1,000	63	45
1,500	77	55

Table 5-4. Internal boundary layer depth after Plate (1971; Equations 5-4 and 5-5)

Inland fetch (m)	Depth (m)
500	51
750	71
1,000	89
1,500	123

Table 5-5. Internal boundary layer depth ranges (based on Tables 5-1 through 5-4)

Inland fetch (m)	Range (m)
500	20 to 173
750	24 to 212
1,000	28 to 245
1,500	35 to 300

Table 5-6. National and State of Florida ambient air quality standards applicable to the proposed site, Hillsborough County, Florida[a]

Pollutant	Averaging time	National		Florida[b]
		Primary standard	Secondary standard	
Suspended particulate matter	Annual geometric mean	75 μg/m^3	60 μg/m^3	60 μg/m^3
	24-hour maximum	260 μg/m^3	150 μg/m$^{3(b)}$	150 μg/m$^{3(b)}$
Sulfur dioxide	Annual arithmetic mean	80 μg/m^3	NA	60 μg/m^3
	24-hour maximum	365 μg/m$^{3(b)}$	NA	260 μg/m$^{3(b)}$
	3-hour maximum	NA	1,300 μg/m$^{3(b)}$	1,300 μg/m$^{3(b)}$
Carbon monoxide	8-hour maximum	9 ppm^b	9 ppm^b	9 ppm^b
	1-hour maximum	35 ppm^b	35 ppm^b	35 ppm^b
Hydrocarbons	3-hour maximum (6 to 9 a.m.)	0.24 ppm^b	0.24 ppm^b	0.24 ppm^b
Nitrogen dioxide	Annual arithmetic mean	100 μg/m^3	100 μg/m^3	100 μg/m^3
Ozone	1-hour maximum	120 ppb^b	120 ppb^b	80 ppb^b

Abbreviations:
ppm = parts per million.
ppb = parts per billion.
NA = not applicable.

[a] From 10 CFR 50, 1976, and Florida Administrative Code, Chapter 17-2.
[b] Concentration not to be exceeded more than once per year.

Table 5-7. Federal and State of Florida significance of impact levels for sulfur dioxide and particulate matter ($\mu g/m^3$)[a]

Pollutant	Averaging time		
	Annual	24-hour	3-hour
Particulate matter	1	5	--
Sulfur dioxide	1	5	25

[a] From 43 FR 118, 1978, and Florida Administrative Code, Chapter 17-2.

Table 5-8. Federal and State of Florida prevention of significant deterioration allowable increments ($\mu g/m^3$)[a]

Pollutant/averaging time	Class		
	I	II	III
Particulate matter			
Annual geometric mean	5	19	37
24-hour maximum[b]	10	37	75
Sulfur dioxide			
Annual arithmetic mean	2	20	40
24-hour maximum[b]	5	91	182
3-hour maximum[b]	25	512	700

[a] From 43 FR 118, 1978, and Florida Administrative Code, Chapter 17-2.

[b] Increment can be exceeded once per year.

Table 5-9. Air quality monitoring instrumentation

Pollutant	Monitor designation	Monitor sponsor	Measurement frequency[a]	Data period	Elevation above ground level (ft)
SO_2 Noncontinuous	T5	TECO	Every 6th day	1/76-12/78	15
	T6	TECO	Every 6th day	1/76-12/78	15
	T11	TECO	Every 6th day	1/76-12/78	15
	T13	TECO	Every 6th day	1/76-12/78	15
	T15	TECO	Every 6th day	1/76-12/78	15
	T17	TECO	Every 6th day	1/76-12/78	15
	H9	HECPC	Every 6th day	1/76-12/78	15
	H54	HECPC	Every 6th day	1/76-12/78	15
Continuous	T1	TECO	Continuous	2/77-4/79	15
	T4	TECO	Continuous	5/77-4/79	15
	T5	TECO	Continuous	2/77-4/79	15
	T7	TECO	Continuous	2/77-4/79	15
	T8	TECO	Continuous	2/77-3/78	15
TSP	T5	TECO	Every 6th day	1/76-12/77	15
	T6	TECO	Every 6th day	1/76-12/78	15
	T12	TECO	Every 6th day	1/76-12/78	15
	T17	TECO	Every 6th day	1/78-12/78	15
	H9	HCEPC	Every 6th day	1/76-12/78	15
	H50	HCEPC	Every 6th day	1/76-12/78	15
	H54	HCEPC	Every 6th day	1/76-12/77	15
NO_2	T5	TECO	Every 3rd day	1/76-12/78	15
	T6	TECO	Every 3rd day	1/76-12/78	15
	T11	TECO	Every 3rd day	1/76-12/78	15
	T13	TECO	Every 3rd day	1/76-12/78	15
	T15	TECO	Every 3rd day	1/76-12/78	15
	T17	TECO	Every 3rd day	1/76-12/78[b]	15
	T18	TECO	Every 3rd day	1/76-12/78	15

[a] Nominal measurement frequency. Refer to Tables 5-12, 5-13, 5-16, and 5-17 for actual number of sampling data points.

[b] No NO_2 data collected at T17 from 1/77 to 12/77.

Table 5-10. Air monitoring programs

Parameter	Frequency	Sample type	Responsibility
Stack emissions, Big Bend 1-3			
SO_2	Continuous (fuel analysis)	Daily composite	CTL/Plant
Opacity	Continuous	In-stack monitor	Plant
Emission tests			
SO_2	1 per year	Stack sample	CTL
Particulates	1 per year	Stack sample	CTL
NO_x	1 per year	Stack sample	CTL
Ambient air monitoring			
SO_2	Continuous	Ambient	CTL
Intermittent system			
SO_2	24 hours every 6 days	Ambient	CTL
TSP	24 hours every 6 days	Ambient	CTL
NO_2	24 hours every 6 days	Ambient	CTL

Abbreviations:
CTL = Central Testing Laboratory.
Plant = Big Bend Station.

Table 5-11. TECO ambient monitoring network audits performed during the period 1976 through 1978
(Sheet 1 of 2)

Company performing audit	Noncontinuous network audit performed[a]	Continuous network audit performed[b]	Persons performing audit
Environmental Research & Technology, Inc.	--	March 2, 1977	A. Sacco, ERT M. Gillespie, ERT R. Durgan, ESE
Environmental Research & Technology, Inc.	--	April 1, 1977	M. Gillespie, ERT H. Chow, ERT R. Durgan, ESE
Environmental Research & Technology, Inc.	--	June 8, 1977	A. Sacco, ERT R. Durgan, ESE
Environmental Research & Technology, Inc.	--	August 24, 1977	A. Sacco, ERT R. Durgan, ESE
Science Associates, Inc.	--	September 12, 1977	E. Franzblau, SAI R. Durgan, ESE
Environmental Science and Engineering, Inc.	November 1977	--	A. Graham, ESE D. Layton, TECO
Environmental Research & Technology, Inc.	--	December 12, 1977	A. Sacco, ERT R. Durgan, ESE
Science Associates, Inc.	--	January 10, 1978	S. Burton, SAI E. Franzblau, SAI D. Brittan, EPA A. Sacco, ERT R. Durgan, ESE M. Jackson, ESE

Note: See abbreviations and footnotes at end of table.

Table 5-11. TECO ambient monitoring network audits performed during the period 1976 through 1978
(Sheet 2 of 2)

Company performing audit	Noncontinuous network audit performed[a]	Continuous network audit performed[b]	Persons performing audit
Environmental Science and Engineering, Inc.	April 1978	--	M. Jackson, ESE K. Hensley, TECO
Environmental Research & Technology, Inc.	--	April 19, 1978	A. Sacco, ERT R. Durgan, ESE
Environmental Science and Engineering, Inc.	November 1978	November 1978	A. Graham, ESE R. Durgan, TECO

Abbreviations:
ERT = Environmental Research and Technology, Inc.
ESE = Environmental Science and Engineering, Inc.
SAI = Science Associates, Inc.

[a] Includes sulfur dioxide and nitrogen dioxide bubblers and total suspended particulate monitors.
[b] Includes continuous sulfur dioxide monitors.

Table 5-12. Summary of ambient 24-hour sulfur dioxide bubbler data in the vicinity of TECO Big Bend, 1976-1978[a] (Sheet 1 of 2)

Station number	Sponsor	Time period	Number of observations	Arithmetic mean ($\mu g/m^3$)	Maximum 24-hour ($\mu g/m^3$)	Second-highest 24-hour ($\mu g/m^3$)
5	TECO	1/76-12/76	133	9	59	54
		1/77-12/77	79	22	52	44
		1/78-12/78	92	5	31	24
6	TECO	1/76-12/76	134	10	86	65
		1/77-12/77	92	11	79	76
		1/78-12/78	31	9	33	33
11	TECO	1/76-12/76	23[b]	8	24	24
		1/77-12/77	103	5	62	22
		1/78-12/78	60	5	21	16
13	TECO	1/76-12/76	15[b]	10	32	--
		1/77-12/77	104	6	42	35
		1/78-12/78	57	8	74	50
15	TECO	1/76-12/76	8[b]	5	13	4
		1/77-12/77	70	6	103	20
		1/78-12/78	61	5	45	19
17	TECO	1/77-12/77	35	7	34	32
		1/78-12/78	73	7	50	44

Note: See footnotes and note at end of table.

Table 5-12. Summary of ambient 24-hour sulfur dioxide bubbler data in the vicinity of TECO Big Bend, 1976-1978[a] (Sheet 2 of 2)

Station number	Sponsor	Time period	Number of observations	Arithmetic mean ($\mu g/m^3$)	Maximum 24-hour ($\mu g/m^3$)	Second-highest 24-hour ($\mu g/m^3$)
54	HCEPC	1/76-12/76	129	10	55	54
		1/77-12/77	98	11	293	40
9	HCEPC	1/76-12/76	59	11	149	94
		1/77-12/77	64	8	60	34
		1/78-12/78	61	8	76	47

[a] From Environmental Science and Engineering, Inc. (1979), Hillsborough County Environmental Protection Commission (1978, 1979, 1980), and Tampa Electric Company (1977a, 1978, 1979a).

[b] Sampling not conducted for the entire year.

Note: Federal primary standards--365 $\mu g/m^3$, 24-hour average (not to be exceeded more than once per year). 80 $\mu g/m^3$, annual arithmetic mean.

State of Florida standards--260 $\mu g/m^3$, 24-hour average (not to be exceeded more than once per year). 60 $\mu g/m^3$, annual arithmetic mean.

Table 5-13. Summary of continuous sulfur dioxide monitoring data obtained in the vicinity of TECO Big Bend Powerplant

Station	Location	Time period	24-hour		3-hour		Concentration ($\mu g/m^3$)				
			Number of observations	Percent data recovery	Number of observations	Percent data recovery	Arithmetic mean	Highest 24-hr (NOL)	Highest 24-hr (RUN)	Highest 3-hr (NOL)	Highest 3-hr (RUN)
T1	East Bay substation	2/77-4/79	708	87.4	5,687	87.7	12	156	172	965	967
T4	Bullfrog Creek	5/77-4/79	639	88.8	5,103	88.6	10	237	237	1,149	1,206
T5	North Ruskin	2/77-4/79	722	89.1	5,784	89.3	14	135	174	767	967
T7	Apollo Beach	2/77-4/79	450	75.0	3,670	63.7	16	135	211	473	520
T8	Gibsonton	2/77-3/78	397	94.5	3,191	95.0	15	99	104	588	650
			State of Florida standards				60	260		1,300	
			EPA secondary standard				--	--		1,300	
			EPA primary standards				80	365		--	

Abbreviations:
NOL = nonoverlapping averages.
RUN = running averages.

Table 5-14. Frequency distribution of 3-hour average sulfur dioxide concentrations measured in the vicinity of TECO Big Bend Powerplant

Station Location Sampling period No. of observations		T1 East Bay Substation 2/77-4/79 5,687		T4 Bullfrog Creek 5/77-4/79 5,103		T5 North Ruskin 2/77-4/79 5,784		T7 Apollo Beach 2/77-5/77 684		T7 Apollo Beach 9/77-4/79 2,986		T8 Gibsonton 2/77-3/78 3,191	
Upper limit of interval													
ppm	µg/m³	I[a]	II[b]	I	II	I	II	I	II	I	II	I	II
0.01	26	90.276	90.276	92.749	92.749	90.180	90.180	92.251	92.251	84.628	84.628	86.775	86.775
0.02	52	5.732	96.008	4.311	97.061	5.411	95.591	2.924	95.175	9.344	93.972	9.025	95.801
0.03	78	1.934	97.943	1.137	98.197	1.539	97.100	2.047	97.222	2.512	96.484	2.131	97.932
0.04	104	0.739	98.681	0.607	98.805	0.743	97.873	0.877	98.099	1.139	97.622	1.065	98.997
0.05	130	0.440	99.121	0.314	99.118	0.432	98.306	0.292	98.392	0.804	98.426	0.407	99.405
0.06	156	0.334	99.455	0.176	99.294	0.328	98.634	0.439	98.830	0.402	98.828	0.157	99.561
0.07	182	0.211	99.666	0.118	99.412	0.173	98.807	9.439	99.269	0.301	99.129	0.125	99.687
0.08	208	0.053	99.719	0.118	99.530	0.242	99.049	0.292	99.561	0.301	99.431	0.094	99.781
0.09	234	0.035	99.754	0.039	99.569	0.156	99.205	0.146	99.708	0.201	99.632	0.063	99.843
0.10	260	0.018	99.771	0.059	99.628	0.156	99.360	0.000	99.708	0.134	99.765	0.031	99.875
0.15	390	0.141	99.912	0.235	99.863	0.294	99.654	0.292	100.000	0.167	99.933	0.094	99.969
0.20	520	0.035	99.947	0.020	99.882	0.207	99.862	0.000	100.000	0.067	100.000	0.000	99.969
0.30	780	0.035	99.982	0.098	99.980	0.138	100.000	0.000	100.000	0.000	100.000	0.031	100.000
0.40	1,040	0.018	100.000	0.000	99.980	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.50	1,300	0.000	100.000	0.020	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.60	1,560	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.70	1,820	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.80	2,080	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.90	2,340	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
1.00	2,600	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
1.00	2,600	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000

[a] Percent occurrence within interval.
[b] Cumulative percent occurrence.

Table 5-15. Frequency distribution of 24-hour average sulfur dioxide concentrations measured in the vicinity of TECO Big Bend Powerplant

Station		T1		T4		T5		T7		T7		T8	
Location		East Bay Substation		Bullfrog Creek		North Ruskin		Apollo Beach		Apollo Beach		Gibsonton	
Sampling period		2/77-4/79		5/77-4/79		2/77-4/79		2/77-5/77		9/77-4/79		2/77-3/78	
No. of observations		708		639		722		85		365		397	
Upper limit of interval													
ppm	µg/m³	I[a]	II[b]	I	II	I	II	I	II	I	II	I	II
0.01	26	90.537	90.537	92.645	92.645	86.427	86.427	88.235	88.235	80.548	80.548	87.406	87.406
0.02	52	8.051	98.588	5.477	98.122	8.449	94.875	7.059	95.294	13.973	94.521	11.083	98.489
0.03	78	0.565	99.153	0.626	98.748	3.186	98.061	3.529	98.824	3.562	98.082	1.259	99.248
0.04	104	0.424	99.576	0.939	99.687	0.831	98.892	1.176	100.000	1.370	99.452	0.252	100.000
0.05	130	0.141	99.717	0.156	99.843	0.831	99.723	0.000	100.000	0.274	99.726	0.000	100.000
0.06	156	0.141	99.859	0.000	99.843	0.277	100.000	0.000	100.000	0.274	100.000	0.000	100.000
0.07	182	0.141	100.000	0.000	99.843	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.08	208	0.000	100.000	0.000	99.843	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.09	234	0.000	100.000	0.000	99.843	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.10	260	0.000	100.000	0.156	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.15	390	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.20	520	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.30	780	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.40	1,040	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.50	1,300	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.60	1,560	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.70	1,820	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.80	2,080	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
0.90	2,340	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
1.00	2,600	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000
1.00	2,600	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000	0.000	100.000

[a] Percent occurrence within interval.

[b] Cumulative percent occurrence.

Table 5-16. Summary of ambient 24-hour suspended particulate matter data in the vicinity of TECO Big Bend, 1976-1978[a] (Sheet 1 of 2)

Station number	Sponsor	Time period	Number of observations	Geometric mean ($\mu g/m^3$)	Maximum 24-hour ($\mu g/m^3$)	Second-highest 24-hour ($\mu g/m^3$)	Standard geometric deviation
5	TECO	1/76-12/76	49	41	143	71	1.54
		1/77-12/77	30	38	103	87	1.96
6	TECO	1/76-12/76	47	36	70	69	1.41
		1/77-12/77	40	37	115	81	1.54
		1/78-12/78	15	39	64	61	1.38
12	TECO	1/76-12/76	6[b]	28	65	49	2.62
		1/77-12/77	45	37	111	71	1.48
		1/78-12/78	49	39	86	78	1.45
17	TECO	1/78-12/78	31	33	79	55	1.37
9	HCEPC	1/76-12/76	57	38	85	76	1.38
		1/77-12/77	54	31	74	55	1.40
		1/78-12/78	61	36	97	70	1.43
50	HCEPC	1/76-12/76	54	31	61	57	1.39
		1/77-12/77	52	32	79	69	1.47
		1/78-12/78	61	38	109	96	1.53

Note: See footnotes and note at end of table.

Table 5-16. Summary of ambient 24-hour suspended particulate matter data in the vicinity of TECO Big Bend, 1976-1978[a] (Sheet 2 of 2)

Station number	Sponsor	Time period	Number of observations	Geometric mean ($\mu g/m^3$)	Maximum 24-hour ($\mu g/m^3$)	Second-highest 24-hour ($\mu g/m^3$)	Standard geometric deviation
54	HCEPC	1/76-12/76	61	38	66	64	1.35
		1/77-12/77	58	38	110	103	1.56

[a] From Environmental Science and Engineering, Inc. (1979), Hillsborough County Environmental Protection Commission (1978, 1979, 1980), and Tampa Electric Company (1977a, 1978, 1979a).

[b] Sampling not conducted for the entire year.

Note: Federal primary standards--260 $\mu g/m^3$, 24-hour average (not to be exceeded more than once per year).
75 $\mu g/m^3$, annual geometric mean.
State of Florida standards--150 $\mu g/m^3$, 24-hour average (not to be exceeded more than once per year).
60 $\mu g/m^3$, annual geometric mean.

Table 5-17. Summary of ambient 24-hour nitrogen dioxide bubbler data in the vicinity of TECO Big Bend, 1976-1978[a,b]

Station number	Time period	Number of observations[c]	Arithmetic mean (μg/m^3)	Maximum 24-hour (μg/m^3)
5	1/76-12/76	133	13	42
	1/77-12/77	79	22	52
	1/78-12/78	87	37	221
6	1/76-12/76	135	12	43
	1/77-12/77	91	17	39
	1/78-12/78	26	20	47
11	1/76-12/76	20[c]	17	37
	1/77-12/77	95	17	43
	1/78-12/78	57	29	101
13	1/76-12/76	16[c]	15	30
	1/77-12/77	94	11	33
	1/78-12/78	56	28	129
15	1/76-12/76	8[c]	15	24
	1/77-12/77	71	13	27
	1/78-12/78	59	26	121
17	1/76-12/76	3[c]	18	22
	1/78-12/78	75	38	165
18	1/76-12/76	1[c]	5	5
	1/77-12/77	96	18	37
	1/78-12/78	27	23	111

[a] From Environmental Science and Engineering, Inc. (1979) and Tampa Electric Company (1977a, 1978a, 1979a).

[b] All studies sponsored by TECO.

[c] Sampling not conducted for the entire year.

Note: Federal primary and State of Florida standard: 100 μg/m^3, annual arithmetic mean.

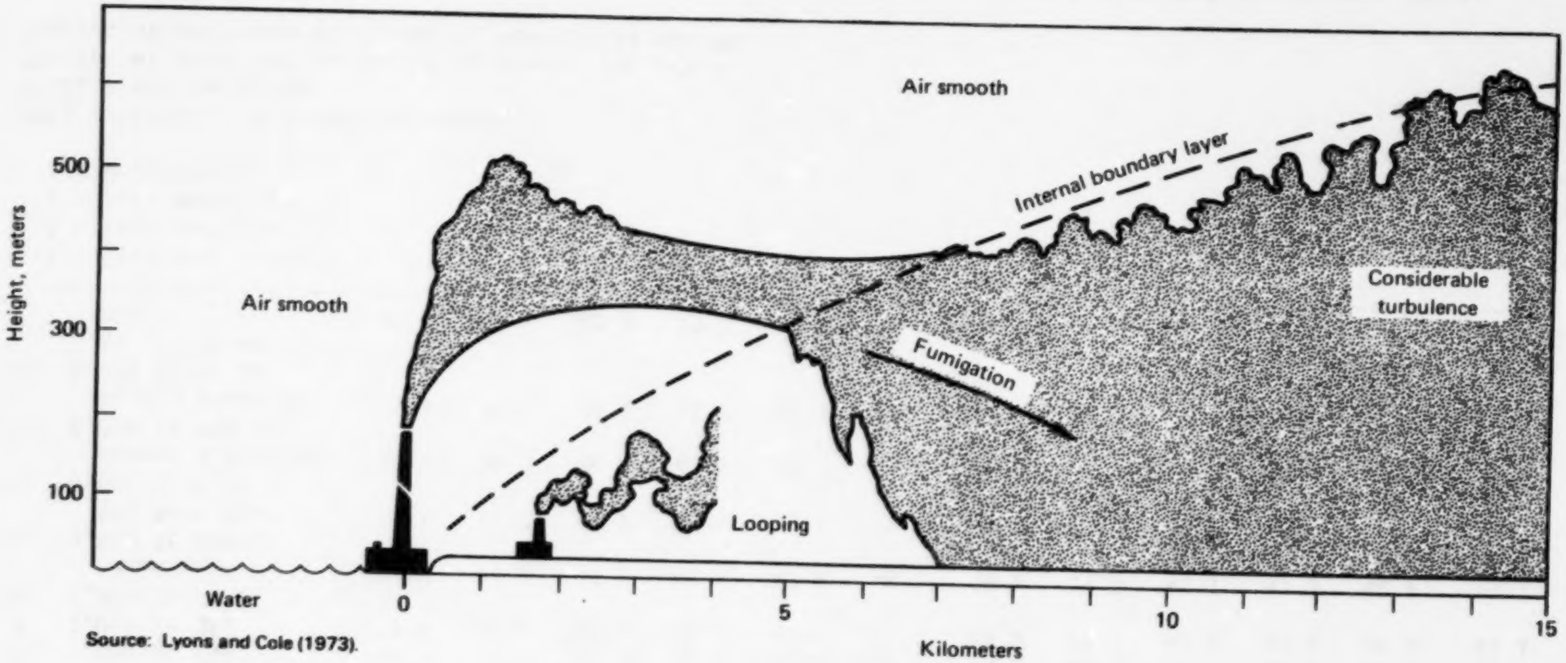
Table 5-18. Summary of ambient residual sound levels at Big Bend Station[a]

Location	Daytime (date and wind direction)						Nighttime (date and wind direction)					
	1974			1978			1974			1978		
	2/12 W	2/13 NW	2/14 SW	1/16 SE	1/17 SW[c]	1/18 NNW	2/12 Calm	2/13 Calm	2/14 E	1/16 SE	1/17[b] SSW[d]	1/18 NNE
1. 1,000 ft SW from station)	55 A	56 A	54 A	60 A	59 A	63 A	54 A	58 A	57 A	59 A	56 A	60 A
2. 1,000 ft ENE	56 A	60 A	59 A	61 A	63 A	59 A	60 A	61 A	59 A	61 A	62 A	61 A
3. 1,000 ft ESE	58 A	60 A	59 A	63 A	64 A	63 A	60 A	59 A	61 A	61 A	64 A	61 A
4. 7,500 ft NE at Adamsville	32 J	33 I	37 I	47 I	47 A	44 I	39 I	39 J	41 I	47 A	40 A	41 I
5. 3,800 ft ESE at Big Bend Road	55 I	47 J	43 I	52 I	56 I	50 A	41 A	47 J	44 A	45 A	54 A	56 I
6. 4,000 ft S at Newman Branch Rd.	33 J	39 J	36 I	43 I	40 J	47 A	46 A	48 J	47 A	40 I	47 A	45 I
7. 8,000 ft SSW at Apollo Beach Rd.	33 I	34 I	37 I	44 I	41 J	45 J	35 A	41 J	42 A	31 I	38 J	42 I
8. 8,000 ft SW at Apollo Beach Motel	40 I	43 I	45 I	45 A	44 I	46 A	36 I	44 J	50 J	41 A	41 I	45 A

Abbreviations:
A = very audible.
J = just audible.
I = inaudible.

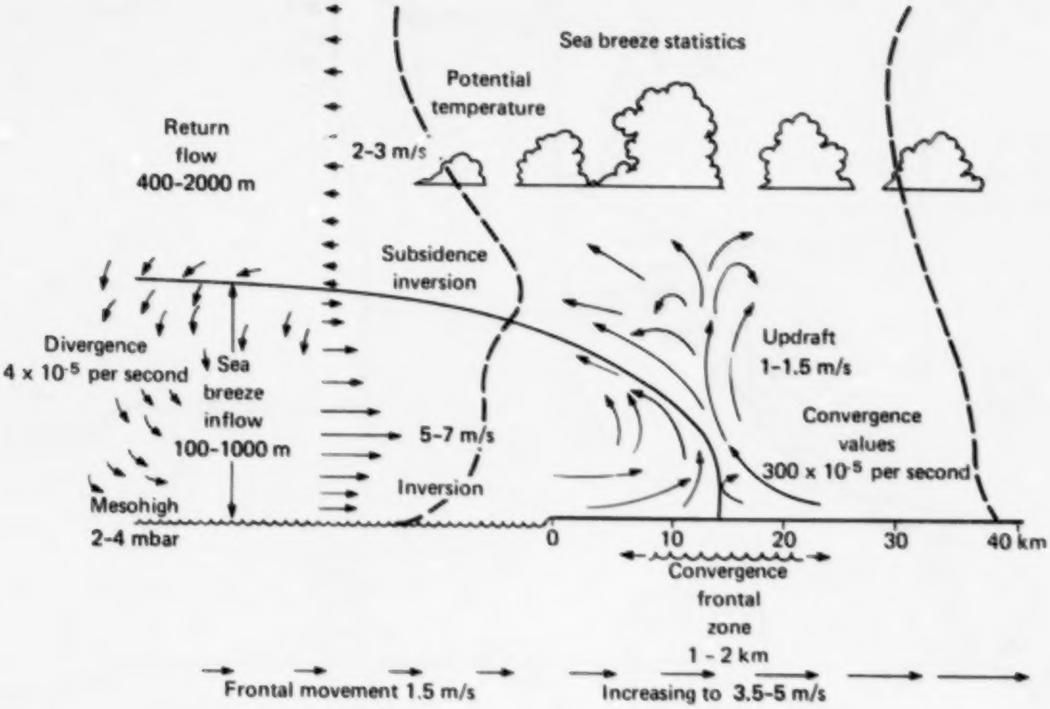
[a] dBA referenced to 0.0002 microbar.
[b] Unit 2 not operating.
[c] Except at positions 1, 2, and 3, where wind was S.
[d] Except at positions 6, 7, and 8, where wind was NW.

Note: Measurements at locations 1-3 are average values, while those at locations 4-8 are minimum values.


Air smooth
Air smooth
Internal boundary layer
Considerable turbulence
Fumigation
Looping
Water
Height, meters
500
300
100
0
5
10
15
Kilometers

Source: Lyons and Cole (1973).

Figure 5-1. The relationship between internal boundary layer and plume fumigation under onshore wind conditions.


Sea breeze statistics
Potential temperature
Return flow 400-2000 m
2-3 m/s
Subsidence inversion
Divergence 4×10^{-5} per second
Sea breeze inflow 100-1000 m
Updraft 1-1.5 m/s
5-7 m/s
Convergence values 300×10^{-5} per second
Inversion
Mesohigh 2-4 mbar
0
10
20
30
40 km
Convergence frontal zone 1 - 2 km
Frontal movement 1.5 m/s
Increasing to 3.5-5 m/s

Source: Cecil Keen in Lyons (1975).

Figure 5-2. Characteristics of a typical sea breeze.

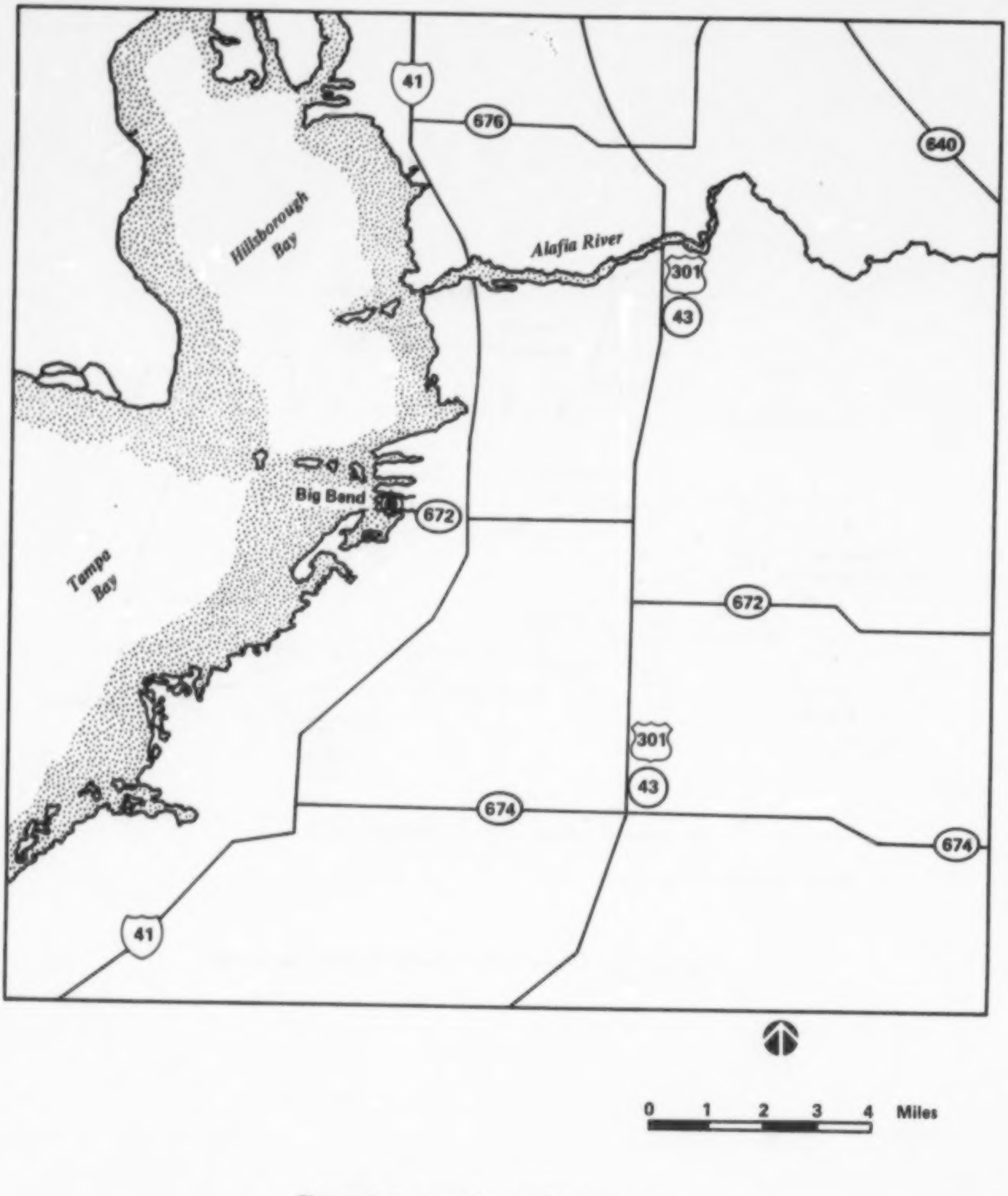

41
676
640
Hillsborough Bay
Alafia River
301
43
Big Bend
672
Tampa Bay
672
301
43
674
674
41
0
1
2
3
4
Miles

Figure 5-3. Location of Big Bend site.

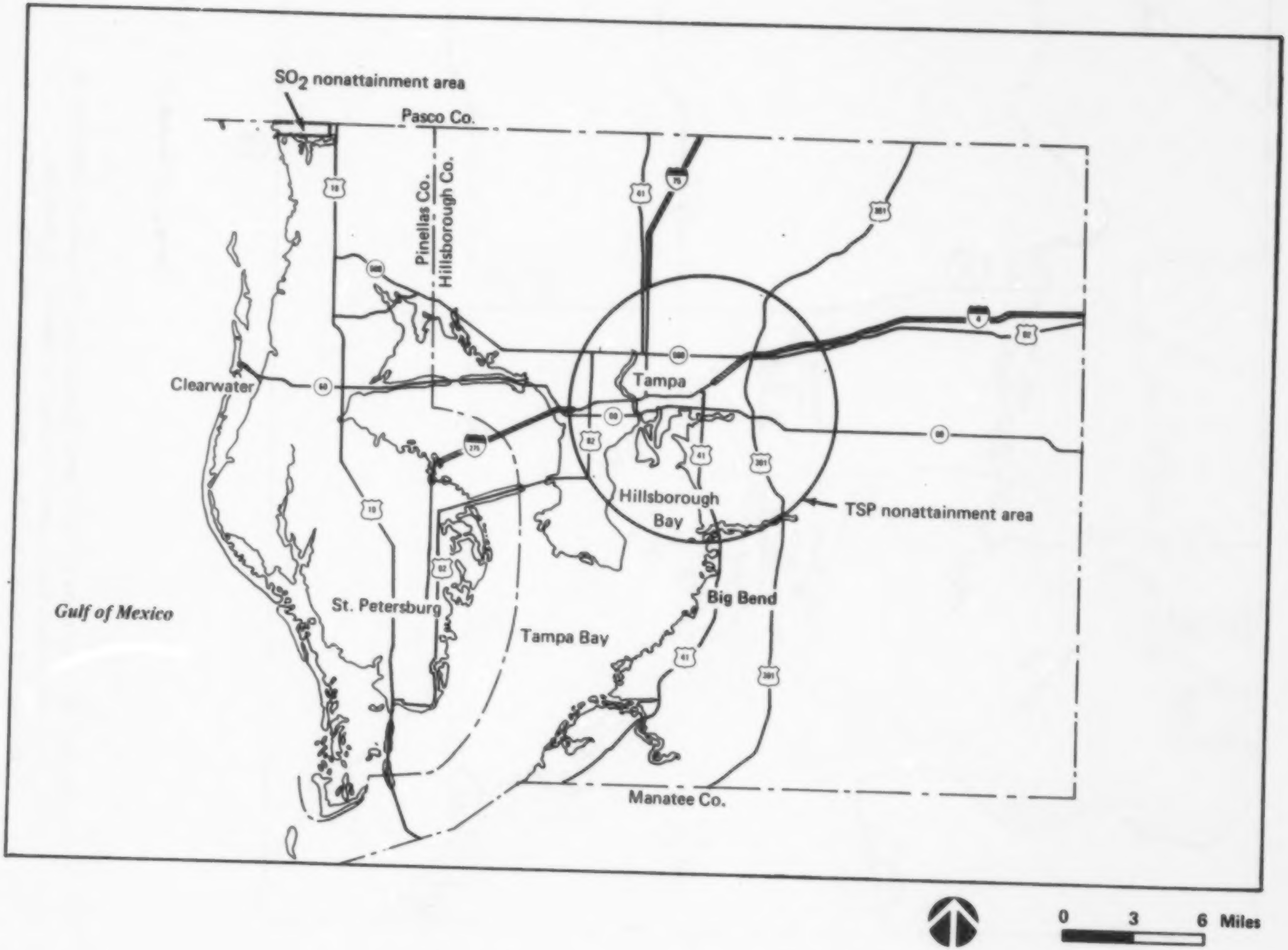

SO$_2$ nonattainment area
Pasco Co.
Pinellas Co.
Hillsborough Co.
Clearwater
Tampa
Hillsborough Bay
TSP nonattainment area
Big Bend
St. Petersburg
Tampa Bay
Gulf of Mexico
Manatee Co.
0
3
6 Miles

Figure 5-4. Locations of SO$_2$ and TSP nonattainment areas in relation to Big Bend Station.

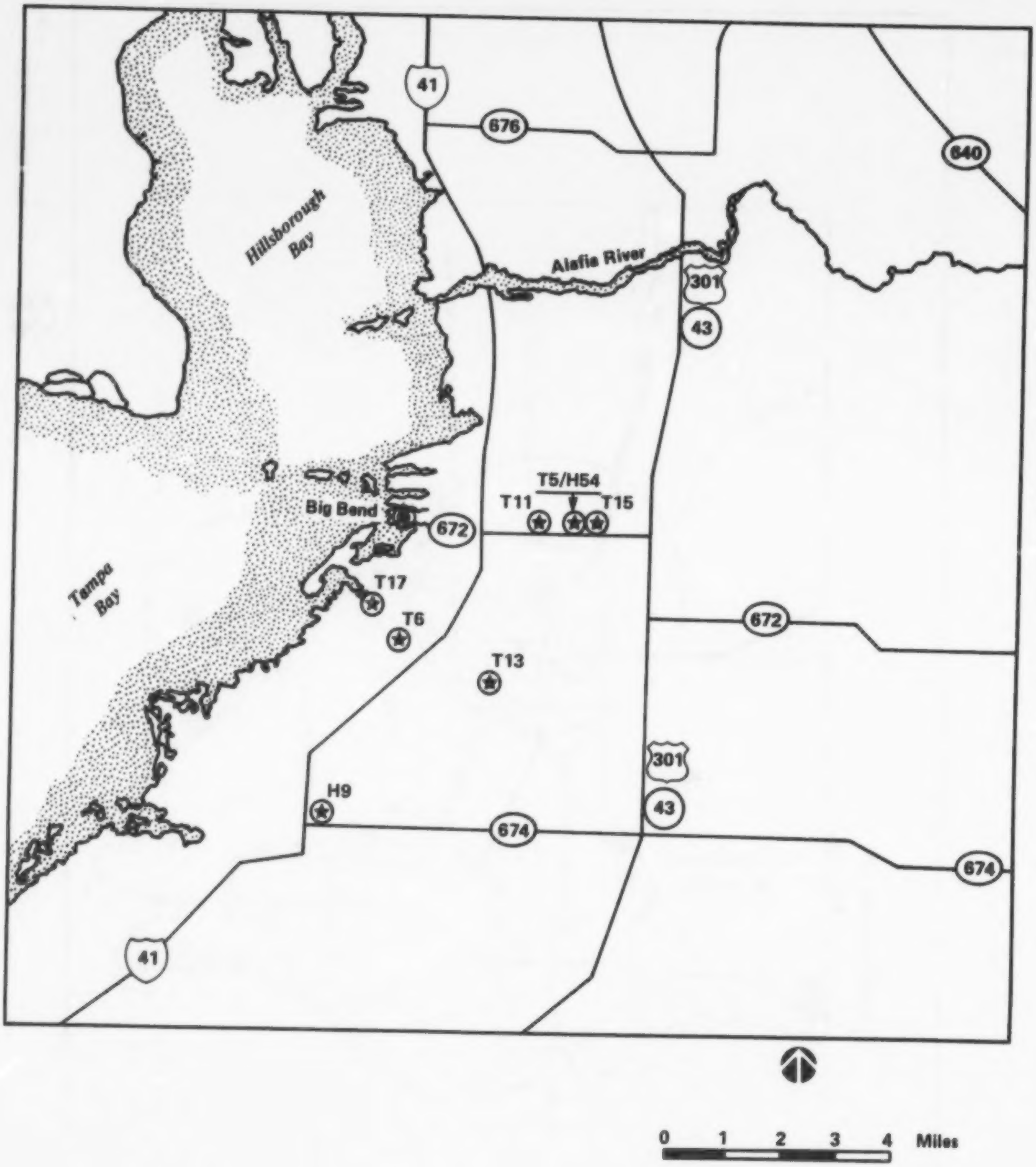

41
676
640
Hillsborough Bay
Alafia River
301
43
T5/H54
T11
T15
Big Bend
672
Tampa Bay
T17
T6
T13
672
301
43
H9
674
674
41
0 1 2 3 4 Miles

Figure 5-5. Locations of TECO and Hillsborough County Environmental Protection Commission 24-hour ambient SO_2 bubbler monitoring stations within a 5-mile radius of Big Bend Station.

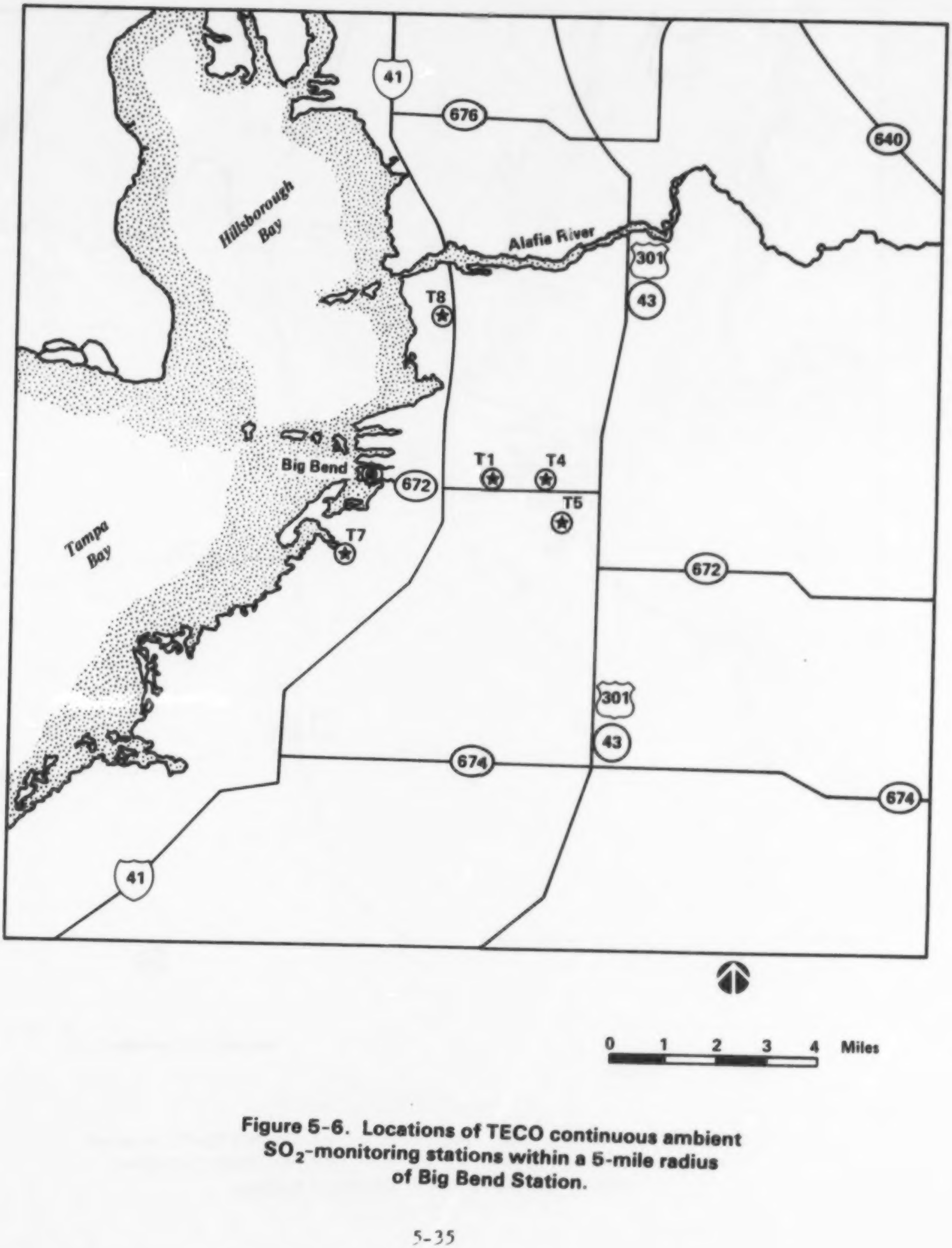

41
676
640
Hillsborough Bay
Alafia River
301
43
T8
Big Bend
672
T1
T4
T5
T7
Tampa Bay
672
301
43
674
674
41
0 1 2 3 4 Miles

Figure 5-6. Locations of TECO continuous ambient SO_2-monitoring stations within a 5-mile radius of Big Bend Station.

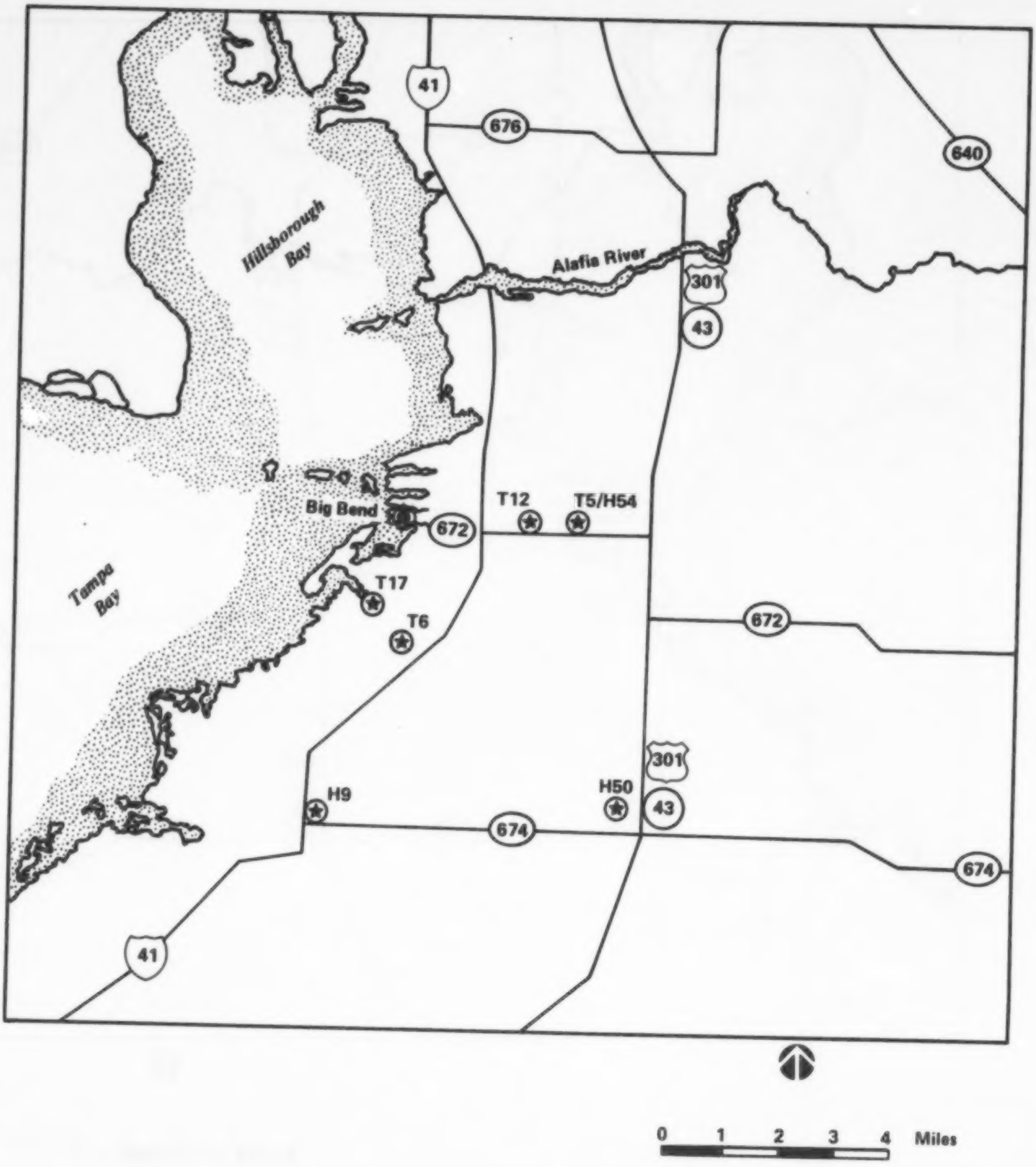

41
676
640
Hillsborough Bay
Alafia River
301
43
Big Bend
672
T12
T5/H54
Tampa Bay
T17
T6
672
301
H9
H50
43
674
674
41
0
1
2
3
4
Miles

Figure 5-7. Locations of TECO and Hillsborough County Environmental Protection Commission 24-hour ambient-TSP-monitoring stations within a 5-mile radius of Big Bend Station.

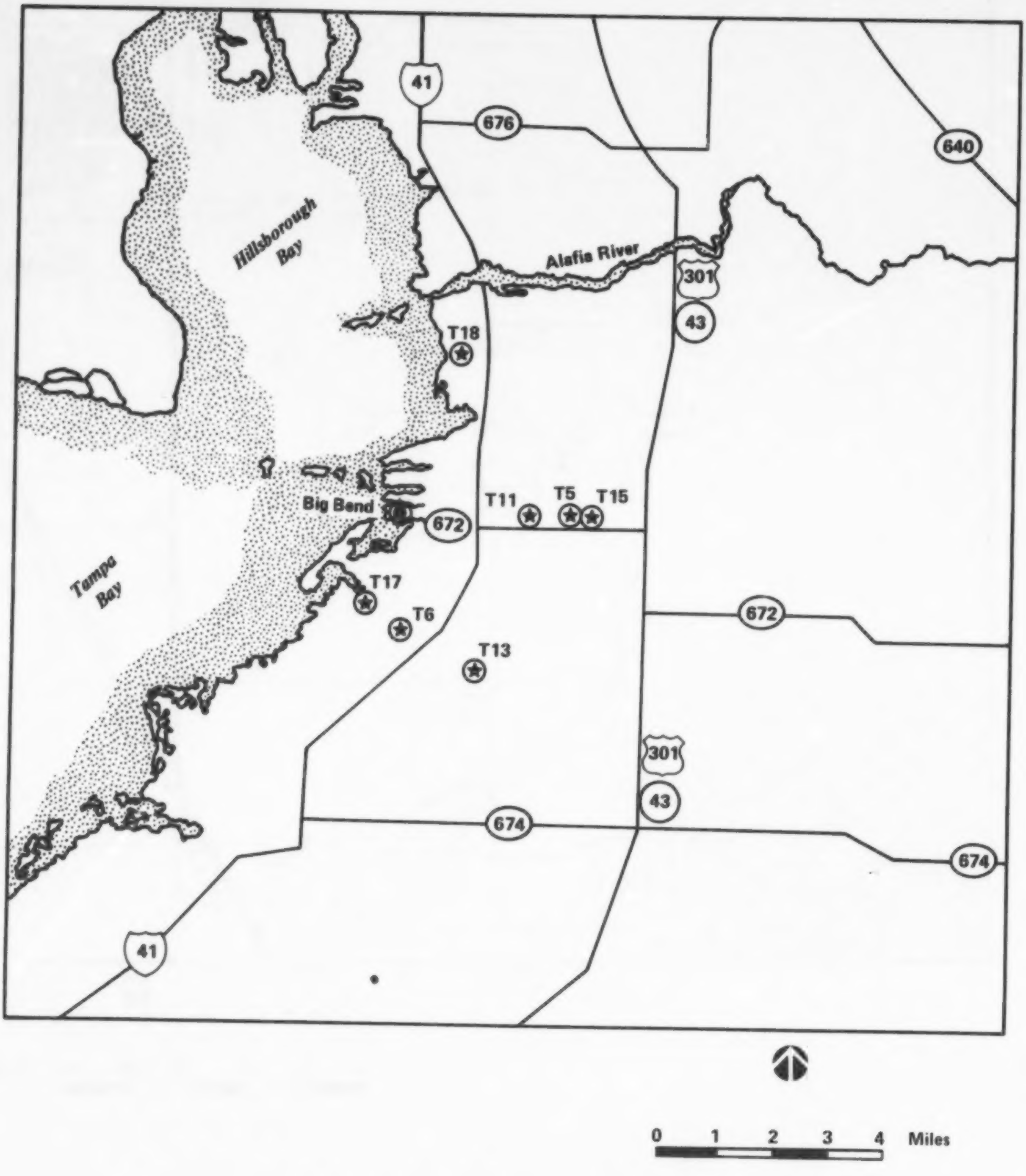

41
676
640
Hillsborough Bay
Alafia River
301
43
T18
Big Bend
672
T11
T5
T15
Tampa Bay
T17
T6
T13
672
301
43
674
674
41
0 1 2 3 4 Miles

Figure 5-8. Locations of TECO 24-hour ambient NO_2 bubbler monitoring stations within a 5-mile radius of Big Bend Station.

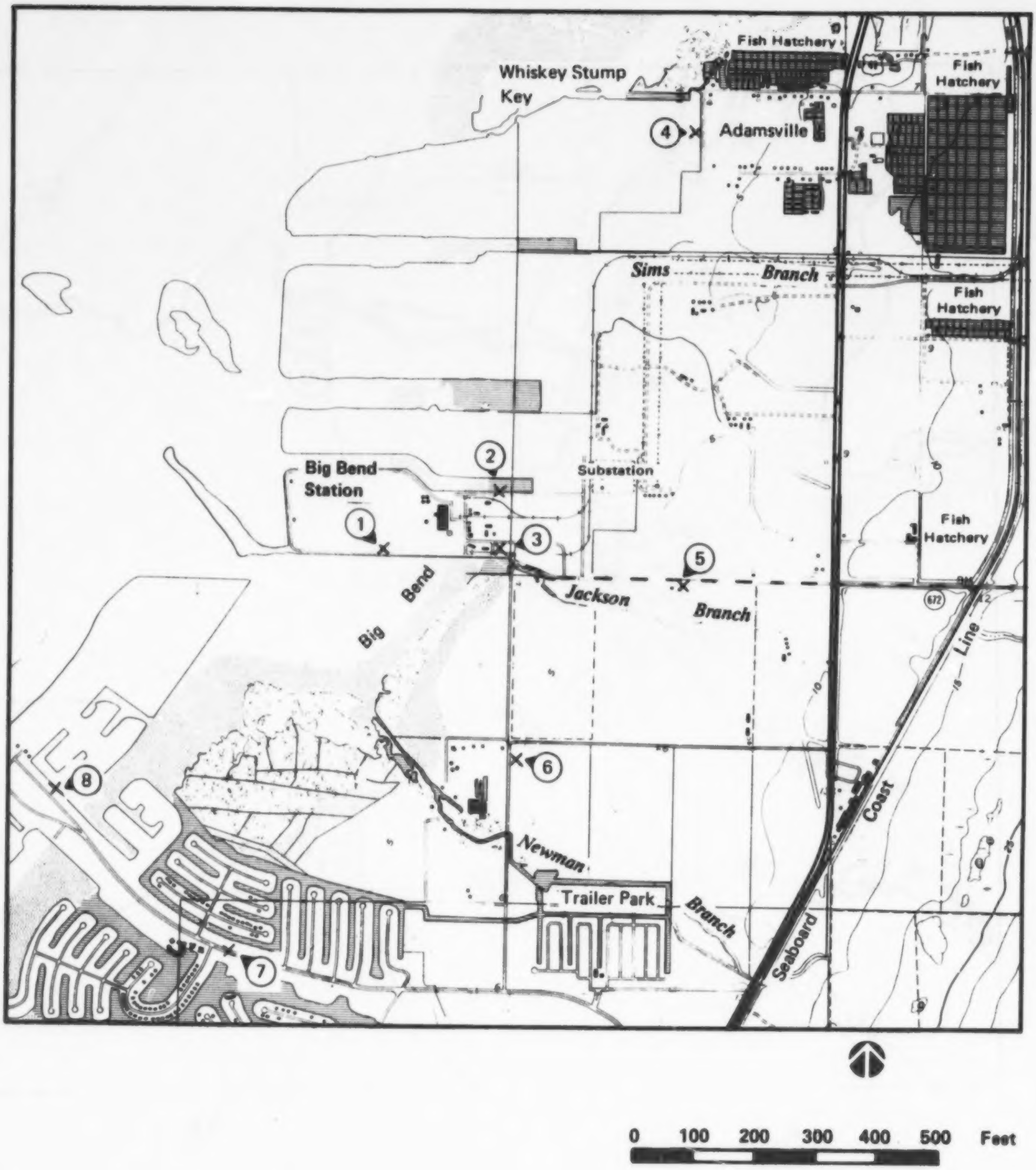

Fish Hatchery
Whiskey Stump Key
Fish Hatchery
4
Adamsville
Sims Branch
Fish Hatchery
2
Big Bend Station
Substation
1
3
Fish Hatchery
5
Jackson Branch
672
Big Bend
Line
6
8
Coast
Newman
Trailer Park
Branch
Seaboard
7
0 100 200 300 400 500 Feet

Figure 5-9. Location of ambient-sound-level monitors at Big Bend Station.

5.2 LAND

5.2.1 PHYSIOGRAPHY AND TOPOGRAPHY

The actual plant site is located on artificial fill dredged from the bottom soils of Tampa Bay. The plant site and surrounding fill is graded to an essentially flat land surface. Natural land surfaces of the Pamlico terrace adjoining the site are nearly flat, broken only by shallow stream channels, swampy areas, and occasional depressed areas.

The present land surface was developed beneath the waters of a shallow sea, the so-called Pamlico Sea, of late Pleistocene time. The former shoreline of the Pamlico Sea is presently at an elevation of about 25 feet above sea level, making it the lowest and youngest of the several former shorelines that are now present on the Florida peninsula.

5.2.2 GEOLOGIC SETTING

The unconsolidated materials deposited in the Pleistocene seas overlie layered sedimentary rocks in two formations of Tertiary (Miocene) age, the Hawthorn Formation and the Tampa Limestone. These Tertiary formations are composed principally of carbonate rocks, although the Hawthorn Formation contains a number of uncemented sediments.

5.2.2.1 Site Bedrock Geology

The Hawthorn Formation lies beneath the Pleistocene deposits and conformably overlies the Tampa Limestone. It consists of grayish, sandy, calcareous, and phosphoritic clays with interbedded thin layers of light-colored limestone and partially cemented shell layers. Occasionally, the limestone and shell layers provide local and restricted sources of ground water. The Hawthorn Formation is exposed near the site in places where the Pamlico terrace has been removed by erosion. This formation is about 65 feet thick at the site.

The Tampa Formation is present beneath the site at about 65 feet below sea level and is believed to be about 400 feet thick in this area. The formation consists of a light-colored, sandy, coquina limestone that is partly silicified, and it is notable as a source of artesian water. It is underlain by thousands of feet of carbonate and phosphate rocks which form the Florida peninsula and the surrounding continental shelf.

5.2.2.2 Subsurface Soil and Rock Conditions

The information in Sections 5.2.2.2.1 and 5.2.2.2.2 is based on soils investigations made in the vicinity of the power station and the ash-disposal site (Stone & Webster Engineering Corporation 1973).

5.2.2.2.1 Ash-Disposal Area

Investigations have determined that the ash-disposal area is underlain by the following sequence of soils: silty fine sand, shells and shell fragments in a silty fine sand matrix, silty sand and clayey sand, marl, and interbedded limestones and clays (bedrock). These soils are illustrated in Figure 5-10, and the locations of borings, well points, and test pits are shown in Figure 5-11. A description of the engineering properties of the soils is provided in the following paragraphs.

5.2.2.2.1.1 Silty Fine Sand

The surface soil zone consists of a layer of dark gray to black fine sand of very uniform grain size. From 3 to 15 percent of the soil by weight is fine enough to pass through a No. 200-mesh sieve (U.S. standard). Approximately 2 percent of the soil by weight is organic material. This surface layer varies in thickness from approximately 4 to 10 inches with an average of about 7 inches. The upper portion of this zone contains many fine roots and weeds. This soil has served as the topsoil for tomato fields.

The topsoil is underlain by a layer of very light gray to white fine sand of very uniform grain size. Approximately 3 percent of this soil by weight passes through the No. 200-mesh sieve. This stratum varies in thickness from 0 to 20 inches with an average of about 8 inches.

Underlying the light gray sand is a layer of brown fine sand of very uniform grain size. Three to 14 percent of this soil by weight is fine enough to pass through the No. 200-mesh sieve. This stratum varies in thickness from 0 to 9 inches with an average of about 3 inches.

5.2.2.2.1.2 Shell Bed

Underlying the surface layer of fine sand is a shell bed consisting of shells and shell fragments in a matrix of fine sand. Due to the varying shell fragment sizes, the material is widely graded. The shell content varies from 20 to 50 percent by weight, and from 7 to 25 percent of the material by weight passes through the No. 200-mesh sieve. The material is loose to compact and at times very highly cemented. The average permeability of this zone is estimated to be less than 5×10^{-3} cm/s. However, the permeability is extremely high in cemented zones or zones containing a high percentage of shell fragments. This layer varies in thickness from approximately 3 to 10 feet.

These soils will be primary foundation soil for the ash-disposal pond. The dikes will be built with 3:1 (horizontal:vertical) slopes from a compacted mixture of these sands and the shells.

5.2.2.2.1.3 Silty Sand

Underlying the upper sand and shells is a zone of silty or clayey fine sand. From 2 to 20 percent of the sand by weight passes through a No. 200-mesh sieve. An estimate of permeability for this zone is 10^{-5} cm/s. The silty sand zone ranges in thickness from 5 to 15 feet.

5.2.2.2.1.4 Marl

Underlying the sand sequence is a layer of marl consisting of calcareous silty clays, clayey silts, and sandy clays varying in color from very light yellowish gray to greenish gray. The material, which is highly plastic, contains from 2 to 5 percent medium to fine sand and is sometimes cemented into nodules ranging from 0.1 to 0.2 inch in diameter. This stratum is very stiff; blow counts are usually in excess of 50 blows per foot.

5.2.2.2.1.5 Bedrock

Underlying the recent soil deposits are the interbedded limestones and clays of the Hawthorn Formation. The top of rock is located at an elevation of approximately -40 mean sea level (msl) at the western boundary of the ash pond site and slopes gently upward toward the east to an elevation of approximately -25 msl near U.S. Highway 41.

The limestone is highly weathered and fractured. There is evidence of solution activity along fractured zones, although no extensive open cavities have been encountered.

The clays of this formation are very stiff and usually sandy. They include gravel-size pieces of phosphate, limestone, and hard nodules of pure clay. In places, the residual character of the soil is clearly indicated by traces of the former rock structure. Investigations by Stone & Webster Engineering Corporation indicate that the Hawthorn Formation averages about 65 feet in thickness at the Big Bend site.

5.2.2.2.2 Powerplant Site

Site soil investigations have determined that the powerplant site is underlain by the following sequence of soils: Tampa Bay dredgings, sandy silt, silty sand and clayey sand, marl, and interbedded limestones and clays (bedrock). Boring locations are shown in Figure 5-12. A description of the engineering properties of these soils is provided in the following paragraphs.

5.2.2.2.2.1 Tampa Bay Dredgings

The surface deposits consist of dredgings from Tampa Bay used to raise the grade of the plant above the water line. The dredgings are predominantly a light gray, very fine sand of uniform grain size. Between 10 and 25 percent of the soil by weight is fine enough to pass through a No. 200-mesh sieve. Less than 5 percent of the soil by weight is gravel particles ranging in size from 1/4 to 1/2 inch. Marine life shells from 5 to 10 percent by volume are also revealed by visual inspection. The thickness of the dredgings ranges from 10 to 15 feet in the plant area.

Since the dredgings were placed by slurry methods, localized pockets of predominantly (up to 90 percent by weight) silt materials occur randomly throughout the fill. Such pockets develop when slurry water drains from the sands into depressions in the surface of the fill and deposits the fine-grained materials. These pockets are up to 2 feet in thickness.

5.2.2.2.2.2 Sandy Silt

Underlying the hydraulic fill are the original bay bottom deposits, consisting of a dark gray to green silt. Generally a very fine sand of uniform grain size accounts for up to 30 to 40 percent of the soil by weight. The silt is nonplastic and very loose. Shell fragments and organic matter are present in this soil. The thickness of this deposit is generally only 3 to 4 feet and varies over the site.

5.2.2.2.2.3 Silty Sand

Except for thickness, the properties of this layer are the same as those described for the layer of silty sand underlying the ash-disposal area. The zone of silty sand beneath the plant site ranges in thickness from 15 to 20 feet (Section 5.2.2.2.1.3).

5.2.2.2.2.4 Marl

The properties of this layer are the same as those described for the layer of marl underlying the ash-disposal area (Section 5.2.2.2.1.4).

5.2.2.2.2.5 Bedrock

The properties of this layer are the same as those described for the layer of bedrock underlying the ash-disposal area (Section 5.2.2.2.1.5).

5.2.2.3 Seismicity

Few earthquakes have occurred in or near Florida since the earliest recorded earthquake in the area in 1663. The U.S. Coast and Geodetic Survey has designated Florida as a Zone 0 area, a zone of little or no probability of earthquake damage. There are fairly well documented records of 14 different earthquakes within the past 300 years with epicenters in or near the state of Florida. These areas are shown in Figure 5-13. Two of these had estimated epicentral intensities of VI (Modified Mercalli Scale). Eleven others had epicentral intensities between IV and V. One or two of the older reports have not been positively identified as earthquakes.

Only two earthquakes are reported to have occurred within 100 miles of the site, and one of these is only tentatively attributed to a seismic source. The other occurred in 1930 and had an estimated epicentral intensity of V.

Six other shocks with sources outside of Florida were probably felt in central Florida. These include the Charleston, South Carolina, earthquake of 1886, earthquakes near Savannah, Georgia, and some of the earthquakes occurring in the Caribbean. The strongest of these was the Charleston earthquake, which had an estimated epicentral intensity of X.

The nearest region of intensive earthquake activity is the Caribbean. There is no known correlation, however, between the Caribbean epicenters of activity and the southeastern United States. An 1880 earthquake in Cuba was felt in southern Florida.

To summarize, Florida is an area of very little earthquake activity, and the probability of a moderate or severe earthquake at or near the site is very low.

5.2.2.4 Subsurface Investigations

Since 1966, there have been several subsurface investigations at the site of the proposed generating unit to evaluate the suitability of the subsurface for powerplant siting and to identify soil characteristics for foundation design. These investigations were supplemented by a review of aerial photographs of the site and by an onsite geological reconnaissance.

The subsurface investigations included rotary borings through the overburden into rock, soil and rock sampling, and field tests. The borings were drilled in accordance with ASTM D1586 under continuous supervision by a qualified engineer or geologist. Standard penetration testing was performed at 2.5-foot intervals to a depth of 10 feet and at 5-foot intervals thereafter. Split-barrel samples were obtained at each test depth. Undisturbed soil samples were obtained in accordance with ASTM D1587. In accordance with ASTM D2113, core borings consisted of continuous sampling of rock, using a rotary diamond bit and core recovery barrels.

All soil and rock samples were examined closely by an experienced engineer or geologist and immediately logged. Representative soil samples were selected for laboratory testing. The laboratory tests performed during various phases of subsurface investigation included Atterberg-limits tests, grain-size analysis, organic-content analysis, specific-gravity tests, compaction tests, and permeability tests on reconstituted samples.

Boring programs undertaken at the site for the existing Big Bend Station Units 1, 2, and 3 date back to 1966. Nine borings ranging in depth from 60 to 125 feet were drilled between 1966 and 1967.

Sixty soil and rock borings were drilled in 1968 to collect date for site investigation and foundation design of transmission lines. Eight of these borings were less than 40 feet in depth, and 35 borings were drilled deeper than 40 feet.

Fifteen miscellaneous borings ranging between 30 and 70 feet in depth were drilled in 1971. Forty-four borings were drilled in 1972 and 1973 for the design of a spray canal, a circulation water intake, and a shipping channel. Eleven of these borings were drilled deeper than an elevation of -40 msl.

For subsurface verification for Unit 4, 11 borings were drilled in 1976 and 1977 adjacent to the existing Units 1, 2, and 3. These borings ranged up to 90 feet in depth.

A subsurface investigation involving 29 hand-auger borings and 25 rotary borings was conducted in 1974 and 1975 to determine the best location for the wastewater treatment ponds. Percolation tests were performed in hand-augered borings ranging from 24 to 80 inches in depth, in accordance with the then existing Chapter 17-13 of the Sewage Disposal Facility Rules of the Florida Department of Environmental Regulation. The rotary borings were drilled to depths between 15 and 35 feet. The purpose of these borings was to evaluate the capability of surface and subsurface conditions to support the wastewater treatment pond dikes.

Soil and rock information obtained in these investigations was used to develop subsurface soil and rock profiles and to verify site geology. A detailed description of site soils and geology is given in Section 5.2.

5.2.3 SURFICIAL SOILS

The distribution and relative composition of soils on the Big Bend site as described in the original soil survey (U.S. Department of Agriculture 1958) are shown in Figure 5-14.

Ruskin fine sand, which covered 46 percent of the site (659 acres), was the most dominant soil (Table 5-19). Tidal marsh and tidal swamp collectively made up

15 percent of the site (approximately 217 acres). Recently man-made land, most of which was reclaimed from tidal marsh and swamp soils, currently occupies about 400 acres. Collectively, Ruskin fine sand, tidal marsh and tidal swamp soils, and recently man-made land occupy approximately 94 percent of the Big Bend site.

Because of recent dredge-and-fill operations and soil classification revisions, perhaps the most useful classification scheme is soil associations, three of which occur on the Big Bend site. The Ruskin-Sunniland-Bradenton association covers approximately 70 percent of the Big Bend site area, and the saltwater swamps and marshes association covers about 25 percent. The remaining area is covered by the Ona-Scranton-Leon association.

A summary of the limitations, restrictions, hazards, and engineering properties for these associations is given in Table 5-20. Nonagricultural soil-use categories that are deemed important for environmental impact assessment on the site are listed together with assessment priorities per category in Table 5-21.

In addition to the limitations and restrictions of the Big Bend soils as given in the 1969 study, other soil characteristics are described in the Florida General Soils Atlas (Florida Department of Administration 1975). The ratings, using the association names previously noted, are given in Table 5-22.

The capability unit classes shown in Table 5-22 relate to the risks and hence the acceptability for agricultural and other uses of the soil associations described therein. The Sunniland and the Bradenton series are both rated Class w-10, meaning soils that have severe limitations in the choice of plants, require special conservation practices, or both. The letter w indicates that water in or on the soil interferes with plant growth or cultivation. The Class VIII w-1 designation for the saltwater swamps and marshes association indicates that soil limitations preclude their use for commercial plants and also restrict their use by wildlife and for recreational, water supply, or aesthetic purposes.

However, there is currently a great variety of uses for the reclaimed soils that constitute made lands on the site of former saltwater swamp and marsh association soils. Recent aerial photographs (1979) of the Big Bend area show residential and industrial development and recreational marinas on dredge-and-fill lands.

Recent investigations of soil profiles in the vicinity of the ash-settling canal (Stone & Webster Engineering Corporation 1973) indicate that surface soils of silty fine sand range from 4 to 10 inches thick and average about 7 inches thick (Figure 5-10).

5.2.4 TERRESTRIAL FLORA AND FAUNA

The characterization of the terrestrial ecology in the vicinity of Big Bend Station is based largely on comprehensive terrestrial programs sponsored by the Applicant. Surveys of terrestrial flora and fauna were conducted at Big Bend Station under the direction of Dr. R. W. Long, professor of botany, University of South Florida. The surveys he directed took place from March through May, 1972. Detailed results of these surveys are included in the draft environmental report for Big Bend Station Units 1 and 2 (Stone & Webster Engineering Corporation 1972). Additional terrestrial programs were conducted from March 1974 through May 1975 and from August through October 1977. The results of these studies were used as baseline data for the assessment of the environmental impact of the proposed Big Bend Unit 4. In addition to the data base generated from these programs, the available literature regarding the terrestrial ecology of central Florida was also utilized.

5.2.4.1 Flora

The Big Bend Station site encompasses approximately 1,675 acres on the eastern shore of Hillsborough Bay. The distribution and areal extent of land use and vegetation cover types on the site, as determined from 1977 aerial photography, are presented in Figure 5-15. The photographic data showed that approximately 30 percent of the site (mostly dredge-and-fill land) was committed to construction, electric power generating units, and associated facilities; 18 percent supported natural vegetation cover; 24 percent was improved or unimproved pastureland for cattle; 19 percent was ponds or marsh; 1 percent was devoted to private residences; and 8 percent had other combined uses.

Davis (1967) mapped the natural vegetation along the coastal (western) portion of the Big Bend site as mangrove swamp forests and the eastern portion as pine flatwoods. In all, seven major cover types were described: agricultural land, old field associations, pine flatwoods, mangrove swamps, salt prairie, freshwater marsh, and disturbed or reclaimed areas. Wunderlin et al. (1975) presented a cover-type map of Big Bend that contained 13 cover categories; however, the site boundaries shown on this map differ from those shown in Figure 5-15. The structure and composition of the natural vegetation at Big Bend have been greatly disturbed by human activities such as logging, cultivation, cattle grazing, construction, and the maintenance of transmission corridors. Consequently, the majority of vascular plants are ruderal.

Plants observed at Big Bend from March 1974 through May 1975 (Tampa Electric Company 1976a) are listed in Table 5-23, and quantitative vegetation data reported by a number of other investigators during the period 1974-1975 are presented in Tables 5-24 through 5-29. Brief characterizations of vegetation types observed on the site at that time are presented in the following subsections.

5.2.4.1.1 Agricultural Land

Agricultural land was approximately 24 percent of the Big Bend site and included both cultivated fields and pastureland for cattle. Principal crops grown in the vicinity of the site included commercial vegetables, tomatoes, and strawberries. The pasture (Area 9, Figure 5-15) contained at least 30 species of plants. In the lower stratum, water pennywort (Hydrocotyle umbellata), crabgrass (Digitaria adscendens), tick clover (Desmodium canum), coinwort (Centella asiatica), sedge (Cyperus tenuifolius), and bahiagrass (Paspalum notatum) had high importance values. Wax myrtle (Myrica cerifera), saltbush (Baccharis halimifolia), Brazilian pepper (Schinus terebinthefolius), and shrub verbena (Lantana camara) dominated the upper stratum. In the absence of cattle grazing, secondary succession in this area would probably produce a pineland community.

5.2.4.1.2 Old Field Associations

Recently abandoned agricultural land occupied approximately 12 percent of the Big Bend site. Most old fields were bordered by wind breaks of Austrialian pine (Casuarina litorea) that approach 40 feet in height. A number of factors contribute to the many variations in the old field communities that become established following abandonment: the degree of disturbance, the time elapsed since disturbance, the soil type, the distance from saltwater, and the distance and alignment of remaining shrubs and trees.

Areas 1, 3, 3A, and 12 (Figure 5-15) were representative of early seres on the site; portions of the former two areas were disturbed by construction activities. Areas 1 and 12 were essentially ruderal communities that contained 34 and 43 species of plants, respectively, with very few woody elements. Species exhibiting high importance values in Area 1 included sesban (Sesbania exaltata), finger grass (Chloris petraea), cow pea (Vigna luteola), dog fennel (Eupatorium compositifolium), and crabgrass. Important species in Area 12 included dog fennel, ragweed (Ambrosia artemisiifolia), dwarf horsetail (Conyza canadensis), tickseed (Bidens pilosa), crabgrass, indigo brush (Indigofera hirsuta), and frog bit (Lippia nodiflora). Although Areas 3 and 3A were essentially ruderal communities, they were successionally more advanced. Goldenrod (Solidago sempervirens var. mexicana and S. microcephala) and nut grass (Cyperus rotundus) exhibited high importance values.

5.2.4.1.3 Pine Flatwoods

Collectively, Areas 5 and 8 accounted for about 4 percent of the site, and represent two of the less disturbed communities. These areas demonstrated later stages of pineland succession following disturbance, presumably by fire, selective cutting, and perhaps cultivation; however, during the latter part of the field surveys, a fire destroyed the vegetation of these areas.

Prior to the occurrence of the fire, the upper stratum in Area 8 was dominated by cabbage palm, saw palmetto, wax myrtle, and saltbush. Mature individuals of slash pine were also present. Important species in the lower stratum included goldenrod, milk pea (Galactia elliottii) and sweet broom (Scoparia dulcis). Garren (1943) concluded that fire is the main factor responsible for perpetuation and maintenance of the species of the pine flatwoods. Both the longleaf and slash pine flatwoods will give way to hardwoods when fire is eliminated.

5.2.4.1.4 Mangrove Swamp

A mangrove community (Area 6) occupied about 12 percent of the Big Bend site and formed a distinct vegetational zone along the southwestern coastal portion of the site where tidal flushing occurred. This was the oldest and least disturbed community on the site. The area contained essentially only three arborescent species: white mangrove, red mangrove, and black mangrove. Mangroves are essential to the stabilization of coastal areas and fulfill several other significant ecological roles (Section 2.3.7; Snedaker 1978).

5.2.4.1.5 Salt Prairie

Area 7 occupied approximately 3 percent of the site and was dominated by halophytic plant species, including sea daisies (Borrichia frutescens), shore grass (Monanthocloe littoralis), and salt grass. This area was transitional between the mangrove swamp (Area 6) and the pine flatwoods (Areas 5 and 8).

5.2.4.1.6 Freshwater Wetlands and Thickets

Areas 4 and 10 were small areas of impeded soil drainage classified as freshwater wetlands; each area showed a low index of similarity (Table 5-30) to all other areas on the site. Area 4 (approximately 4 acres in size) had the highest plant diversity of any area studied at Big Bend. The soil was saturated or covered in some areas with surface water. The upper stratum was dominated by low trees and shurbs, including elderberry, Brazilian pepper, wax myrtle, saltbush, and southern willow. Common species in the lower stratum included crownbeard (Verbesina laciniata), tickseed, panic grass (Panicum perpureum), and ragweed. Area 10 included a small pond that had a maximum water depth of approximately 3 feet. Common plant species along the pond margin included water arrowhead (Sagittaria graminea), water pennywort, smart weed (Polygonum punctatum), water-hyssop (Bacopa cyclophylla), cattail (Typha latifolia), and black rush (Juncus roemerianus). Surrounding the pond was a low marshy area dominated by cordgrass (Spartina bakeri). In the 1977 survey, most of the open water had disappeared due to encroachment of herbaceous species.

In addition to the areas already discussed, a freshwater drainage canal traversed the southern portion of the site. The eastern end of the drainage canal was headed by a small freshwater marsh. The western portion of the canal merged with a brackish mangrove-Spartina marsh before discharging into Tampa Bay. The species from this area included both mesic and halophytic plant forms.

5.2.4.1.7 Disturbed and Reclaimed Areas

Several portions of the Big Bend site were categorized as disturbed or reclaimed areas. These included dredge-and-fill land, the powerline right-of-way, and roadside areas.

Dredge-and-fill land reclaimed for the construction of the power plant facilities was approximately 25 percent of the site. Areas not committed to construction were in early stages of colonization by annual weeds and halophytes. If left undisturbed for many years, the species complex in these areas probably would broaden to resemble old field succession and later would broaden to resemble shore hammock succession. However, reclaimed lands are difficult for plants to colonize; the strongly alkaline soil, the high salt content, the absence of organic components, and rapid leaching all combine to restrict plant growth.

The powerline right-of-way (Area 2) was maintained to some extent by periodic mowing. Dominant plant species were essentially ruderal in nature and included Bermuda grass (Cynodon dactylon), tickseed, and ragweed. Roadside areas also contained numerous species of annual and perennial weeds.

In conclusion, floristic habitats found on the Big Bend site were quite disturbed and for the most part were common elsewhere throughout Hillsborough and surrounding counties. The species composition of Areas 1, 2, 3, 3A, and 12 were the most similar (Table 5-30). The mangrove swamp (Area 6) and freshwater marsh communities (Areas 4 and 10) were ecologically the most unusual and most sensitive areas on the site.

5.2.4.2 Fauna

5.2.4.2.1 Amphibians and Reptiles

Information included in this section is based on reports submitted to the Applicant by Long (1974b, 1975) and Wunderlin et al. (1977). Amphibian and reptile sampling occurred on the Big Bend site only between June 1 and August 31, 1974, and from August 1 through October 31, 1977. Information from the Beacon Key site (herein used as comparative data) was collected from March 1 through November 30, 1974. Other supportive regional information was taken from Layne et al. (1977).

Ninety-four species of amphibians and reptiles have been reported from west-central Florida (Layne et al. 1977). At least 81 of these species have been documented in Hillsborough County (Table 2-15).

Layne et al. (1977) lists 31 different habitats in west-central Florida, but only about 11 of these are expected on or near the Big Bend site (Table 2-16). Only four of these are expected to have significantly diverse amphibian and reptilian fauna: freshwater marsh, lakes and ponds, rivers and streams, and flatwoods. These habitats are scarce or absent on the Big Bend site.

There are three major habitats on the Big Bend site (i.e., typical flatwoods, mangrove swamp, and pasture and croplands). The typical flatwoods has the highest species diversity (i.e., 45) of any major habitat in the region or on the Big Bend site. Although much of the Big Bend site is either mangrove swamp or pasture and croplands, these habitats have a relatively undiversified amphibian and reptilian fauna. Two amphibian species and 10 reptile species may occur in mangrove habitats, and 15 reptile species may occur in pasture and croplands.

5.2.4.2.1.1 Amphibians

Twenty-six species of amphibians could occur in west-central Florida and 25 have been documented in Hillsborough County (Layne et al. 1977). The Florida chorus frog and ornate chorus frog have not been separated taxonomically in previous studies. Six species of amphibians were reported on the Big Bend site by Long (1974b). No amphibian observations were made on the site by Stone & Webster Engineering Corporation (1972). Long (1975) reported two species not found at the Big Bend site (i.e., pine woods tree frog and greenhouse frog) from Beacon Key, which is approximately 10 miles south of the Big Bend site. The greenhouse frog is uncommon in the region.

The six species of amphibians that were observed on the site are common regionally in their preferred habitats. During the breeding season they are generally restricted to freshwater streams, marshes, and ponds. Because of the scarcity of permanent freshwater on the Big Bend site, these six species of amphibians are probably uncommon there. The species do, however, breed in intermittent pools caused by rains; hence, any part of the site where these intermittent pools are formed may be an important habitat. Two of these species, the bullfrog and green tree frog, typically occur in aquatic environments throughout the year, and the green tree frog sometimes occurs in saline mangrove swamps or in terrestrial habitats near water. The other four species observed are the southern toad, eastern narrowmouth toad, squirrel tree frog, and southern leopard frog. They may also be found in terrestrial flatwoods communities, but they usually do not occur far from water.

These 6 species were found in only 4 of the 13 habitats where surveys were conducted on the Big Bend site in 1974 and 1975.

A minimum of 73 amphibians were observed on the site (Table 5-31). Based on the number of vocal calls, eastern narrowmouth toads (50 to 75 calls) and green tree frogs (10 to 20 calls) were predominant in the freshwater marsh. Southern toads and southern leopard frogs also occurred in the marsh. Amphibian diversity, abundance, and distribution were lower onsite than would be expected. No amphibians were reported in 9 of the 13 habitats that occur on the site (Table 5-31).

Long (1975) reported similar findings at Beacon Key based on 15 samples from March through November 1974 (Table 5-32). Although squirrel tree frogs and pine woods tree frogs should be common to abundant in typical flatwoods, they were not reported as common at either site, possibly because they were not surveyed during the peak of their activity.

5.2.4.2.1.2 Reptiles

Fifty-nine species of reptile have been reported in west-central Florida, and fifty-six of them were recorded in Hillsborough County by Layne et al. (1977; Table 2-16). The Mediterranean gecko and Cuban brown anole, introduced exotics, are generally restricted to the Tampa area.

The 56 species of reptiles reported in Hillsborough County include 15 species of turtles (including 3 sea turtles), 1 species of alligator, 11 species of lizards, and 29 species of snakes. Twelve of the 15 turtle species would occur only in aquatic habitats. The gopher tortoise and Florida or Gulf Coast box turtle are the only terrestrial turtle species. All 11 species of lizards are terrestrial. The dusky pygmy rattlesnake, the eastern coral snake, the eastern diamondback rattlesnake, and the Florida cottonmouth are poisonous snakes in the region. Nine snake species are entirely terrestrial and 6 species are mostly aquatic.

Long (1974b) reported 12 species of reptiles at the Big Bend site. He recorded an additional 9 species at Beacon Key in 1974 and 1975. The Gulf Coast box turtle and yellow rat snake were the only reptiles reported at Big Bend that were not recorded at Beacon Key.

The habitats at Beacon Key are less disturbed than those at the Big Bend site; this may be the reason Beacon Key has more reptiles and more species of reptiles (19 species) than the Big Bend site (12 species).

The powerline right-of-way, freshwater marsh, palmetto-pine association, and Myrica-Baccharis association appear to be the only habitats that have been intensively surveyed at the Big Bend site. Reptiles were recorded in only 2 other habitats (i.e., salt prairie and old field). No reptiles were reported from 7 of the 13 habitats on the Big Bend site (Table 5-31). Reptiles were recorded in 10 of 12 habitats on the Beacon Key site (Table 5-32).

Four species of lizards, three species of turtles, and five species of snakes were found at Big Bend. The lizards were generally more common in the drier, more open areas, although a ground skink was found near the freshwater marsh. The snakes were found in aquatic and terrestrial habitats. The eastern diamondback rattlesnake was found only in the salt prairie and palmetto-pine areas. The indigo snake, the only species of special status in Florida found on the Big Bend site, was recorded only in the Myrica-Baccharis association.

Only 3 species of reptiles were found with any regularity at the Big Bend site. Ten green anoles were found in the palmetto-pine association, 12 newly hatched southern black racers were found in the powerline right-of-way, and 5 adult racers were found in the palmetto-pine association. The southeastern five-lined skink occurred in more habitats (i.e., four) than any other reptile species, but it was most common in the old field.

5.2.4.2.1.3 Discussion

Six species of amphibians and 12 species of reptiles were found on the Big Bend site (Long 1974b). Long (1975) also reported 8 amphibian and 19 reptile species from Beacon Key, which is about 10 miles south of the Big Bend site. Twenty-nine amphibian and reptile species were reported for the region during those two studies. Whereas 81 species of amphibians and reptiles have been reported in Hillsborough County, less than 25 percent (18 species) were recorded during studies at Big Bend.

Although species diversity is relatively high (81) in Hillsborough County, diversity in a smaller geographic area (e.g., the Big Bend site) should be lower. The 81 species recorded in Hillsborough County were noted from at least 31 different habitats. Only about 13 habitats, some of which are small, occur on the Big Bend site. At least half of these 13 habitats have been disturbed in some way, thus reducing the possibility of occurrence of some species. Intermittent pools formed by rainwater provide breeding areas for several species of toads and frogs, but permanent freshwater is relatively uncommon. Many salamanders, water turtles, and water snakes, which depend on permanent aquatic habitats, may be limited by habitat restrictions. Also, many of the reptiles, particularly lizards and snakes, have limited reproductive capabilities (i.e., few young per litter or clutch), and they are seldom common or abundant even in relatively undisturbed preferred habitats.

5.2.4.2.1.4 Summary

Perhaps the limited observations of amphibians and reptiles on the Big Bend site result from limited sampling. Observations were made for a maximum of 10 days during a 14-month study period and some habitats were not surveyed. Some species were probably undetected since the surveys did not coincide with peak activity periods. Toads and frogs are most vocal during the early spring breeding season. This would also have been the best time to search for salamanders, newts, and sirens. The lack of significant turtle observations is probably a result of limited aquatic habitat.

Because of zoogeographic range limitations, no state or federally protected amphibians have been reported on the site, and none are expected. Three protected reptile species of special status might occur on the Big Bend site. The eastern indigo snake, which was recorded on the site in the Myrica-Baccharis association, could also occur in the dry prairie, mangrove swamp, and typical pine flatwoods. Disturbance of these habitats on the site should be minimized as much as possible, especially the Myrica-Baccharis association. The gopher tortoise could occur in the dry prairie or typical flatwoods, but its occurrence on the site is unlikely. The American alligator could occur near the mangrove swamp or possibly in ditches or canals leading into the site from Tampa Bay. Alligators could occur on the site, but their abundance would be low.

5.2.4.2.2 Birds

Information included in this section is based on reports submitted to the Applicant by Long (1974a, 1975), Wunderlin and Long (1975a,b), Wunderlin et al. (1977), and Stone & Webster Engineering Corporation (1972). Long and Wunderlin conducted studies at Big Bend from March 15 through April 30, 1974, December 1, 1974, through May 31, 1975, and August 1 through October 31, 1977. However, the only intensive sampling was conducted from March through May 1975, when about half of the habitats were surveyed at least once. During other survey periods, relatively few habitats were surveyed or only miscellaneous observations reported. Stone & Webster Engineering Corporation (1972) reported miscellaneous bird sightings in five habitats on the Big Bend site from April 15 through May 30, 1972.

Supplementary information from the Beacon Key site (herein used as comparative data) was obtained for the period June 1, 1974, through February 15, 1975 (Long 1975). Other supportive regional information was taken from Layne et al. (1977).

Approximately 370 species of birds have been reported from west-central Florida (Layne et al. 1977). Three hundred and three species, including 6 subspecies and 5 introduced species, have been reported on or near the Big Bend site in Hillsborough County (Table 2-17).

Although Layne reports 31 different habitats in west-central Florida, only 11 of these habitats are expected on or near the Big Bend site (Table 2-17). Fifty-six of the 292 native species, 4 of the 5 exotic or introduced species, and 1 of the 6 subspecies have not been reported in Hillsborough County in habitats similar to those found on the Big Bend site. Therefore, only 242 species would have a reasonable chance of occurring on the Big Bend site.

Of the 11 habitats that occur on or near the Big Bend site, those that would have the greatest potential avian diversity would be the freshwater marshes (93 species); typical flatwoods (81 species); pasture and croplands (80 species); and dunes, beaches, and flats (79 species; Table 2-17).

The mangrove swamp and typical flatwoods are the dominant native habitats on the Big Bend site. The flatwoods would have a high species diversity (81), and the mangroves would have a moderate diversity (47 species). Some regional habitats (i.e., dry prairie, freshwater marsh, lakes and ponds, and rivers and streams) are relatively scarce or absent in the immediate vicinity of the Big Bend site. Species occurring in these habitats would be scarce on the site.

One hundred and four species of birds have been identified on the Big Bend site (Table 5-33). Long reported 118 species at Beacon Key from June 1974 through February 1975. Thirty-two of those species were not found at Big Bend. A total of 136 species were identified from these two surveys. Of the 32 species not found at Big Bend, most were either migrants or species normally associated with hardwood habitats.

Of the 88 species that could occur on the site as permanent residents, 62 were reported. Some of the more common species were the willet, red-winged blackbird, eastern meadowlark, and cattle egret. Only 1 of the 26 species of permanent residents not reported at Big Bend is not expected on the site because of a lack of proper habitat. The other 25 species would be expected, but in varying degrees of abundance.

Only 7 of 23 species of summer residents were reported on the site. The reddish egret, roseate spoonbill, frigatebird, and least tern (all summer residents) were observed on the Big Bend site and are given special status in Florida. Most of the other summer residents not reported are either very rare or do not occur in habitats on the site. Thirty-three of 85 wintering species were reported on the site, but none were common. The semipalmated sandpiper and rough-winged swallow were the only transients reported.

Of the 13 habitats on the Big Bend site, only 7 were surveyed intensively. These were the intermittent beach, mangrove, salt prairie, palmetto-pine; pasture, pasture pond, and old field. Data for other habitats were based on miscellaneous sightings.

The intermittent beach had the greatest species diversity and abundance of all habitats on the Big Bend site; 42 species were recorded. The highest numbers were recorded in March and April 1975, when 19 species and 85 individuals were found. Willets, black-bellied plovers, Wilson's plovers, ruddy turnstones, and least terns were the most commonly sighted species. The majority of species observed in this habitat were shorebirds, gulls, terns, and wading birds. Sixteen of the 21 species of birds that have special status (Federal or Florida Game and Fresh Water Fish Commission) (FGFWFC) were recorded in this habitat.

Thirty-six species were reported in the mangrove swamp (Table 5-33). Most of these were miscellaneous sightings because no transect surveys were conducted and no abundance estimates were available. Most of these species were found at the intermittent beach. Nine of 21 special-status species were found in mangroves.

Thirty-three species were found in the palmetto-pine association. Carolina wrens and rufous-sided towhees were common. The glossy ibis and prairie warbler were the only species of special status to be reported. Most birds reported in this habitat were fairly common (i.e., red-tailed hawk, bobwhite, mourning dove, blue jay, and house wren).

Thirty species were reported in the Myrica-Baccharis association. Again, the species composition for this habitat was similar to that for the intermittent beach and mangrove habitats. Ten of 21 special-status species were found in the Myrica-Baccharis association.

The pasture and freshwater marsh were the only other habitats with a relatively high species diversity. Twenty-eight species were recorded in the pasture, where cattle egrets and eastern meadowlarks were common. The only species of special status found in this habitat were the brown pelican, osprey, and sandhill crane. The freshwater marsh has a greater potential species diversity (93) than any other habitat on the Big Bend site. However, because marshes are scarce on the site, only 26 species were reported. This marsh is important to many wildlife species on this site, but only five special-status species were found.

The diversity in other habitats ranged from 1 to 19 species. Habitats with low diversity were the powerline right-of-way (8 species), palmetto-Juncus association (6 species), salt prairie (7 species), cosmopolitan (10 species), and old field (19 species).

5.2.4.2.2.1 Discussion

One hundred and four species of birds were reported on the Big Bend site during surveys in 1972, 1974, 1975, and 1977. Only 5 previously unreported species were reported in 1977. These include the black-necked stilt, pileated woodpecker, red-shouldered hawk, roseate spoonbill, and yellow-crowned night heron. Long reported 118 species at Beacon Key, of which 32 had not been reported at Big Bend (Table 5-34).

Greatest species diversity, based on combined surveys at Big Bend, was reported along the intermittent beaches (47 species) and in the mangroves (36 species). The least amount of diversity was in the palmetto-*Juncus* association (6 species), salt prairie (7 species), powerline right-of-way (8 species), and cosmopolitan (10 species).

Many species utilize a variety of habitats (e.g., 12 species were recorded in five or more habitats). The mockingbird and loggerhead shrike were reported in eight habitats; great blue herons and red-winged blackbirds in seven habitats; ground doves in six habitats; and cattle egrets, killdeers, mourning doves, blue jays, fish crows, palm warblers, and boat-tailed grackles in five habitats.

Twenty-one of the 42 species with special status that could occur in the region were reported on the Big Bend site.

Sixteen special-status species were reported along the intermittent beaches, an area used primarily for resting and feeding. Only the American oystercatcher, least tern, royal tern, Caspian tern, and black skimmer could breed in this habitat in the region, but none are expected on the Big Bend site. Ten special-status species were found in the *Myrica*-*Baccharis* association, which is also mainly a resting and feeding area. Nine special-status species were found in the mangroves. Several species of herons, egrets, and ibis also could nest there, although no nesting was reported.

The eastern brown pelican is the only federally listed endangered species reported on the Big Bend site (44 FR 12, 3,636-3,654). Although it was consistently reported during all survey periods, it is unlikely that it nests on the site.

The FGFWFC lists 14 species of special concern that could occur on the Big Bend site, and 8 of them were reported. The only one that the FGFWFC lists as an endangered species is the wood stork. Those species listed by the FGFWFC as threatened and found onsite are the brown pelican, American kestrel, sandhill crane, and the least tern. The American oystercatcher, reddish egret, and roseate spoonbill are listed as species of special concern. Not one of these FGFWFC species was reported to nest on the site. If any of these species breed on the Big Bend site, nesting would probably occur in the mangroves or along the intermittent beaches.

The Florida Committee on Rare and Endangered Plants and Animals (FCREPA 1976) lists 42 special-status species in the region, and 21 of them were reported on the site (Kale 1978). Twelve species not included on the Federal or state lists were found on the Big Bend site and are considered species of special concern by the FCREPA. These include 3 heron species, 2 egret species, 1 bittern species, 2 ibis species, 2 tern species, 1 skimmer species, and 1 warbler species. None have been reported to nest on the site.

5.2.4.2.2.2 Summary

Florida has an extremely diverse avifauna, which includes large numbers of permanent residents, winter residents, and transients. The many terrestrial and aquatic (both freshwater and saltwater) habitats offer resting, feeding, and nesting areas for many birds. Human disturbance and habitat destruction are critical problems facing the bird life of Florida.

Many native habitats in Florida are being utilized for industrial expansion, urban housing, grazing, and agriculture. Several native habitats exist on the Big Bend site, and they support a diverse avifauna. The intermittent beaches, mangroves, and palmetto-pine associations (typical flatwoods) are probably the most important bird habitats on the site. The freshwater marsh is also important.

The intermittent beaches are important feeding and resting areas for terns, shorebirds, and wading birds. More species of special status were recorded in this habitat than in any other habitat on the Big Bend site.

Mangroves are also important for several species. Mangroves serve primarily as a feeding and resting area for herons, egrets, and ibis, but several of these species nest almost exclusively in mangroves. Most of the species nesting in mangroves, however, usually nest on offshore islands. Also, three terrestrial species, the gray kingbird, mangrove cuckoo, and black-whiskered vireo, occur mainly in this habitat. Nine special-status species were reported in mangroves on the site.

The palmetto-pine association is the most important terrestrial bird habitat on the Big Bend site. Although only a few special-status species were recorded there, many species are restricted to this area (e.g., great horned owl and woodpeckers) and do not occur in other habitats.

5.2.4.2.3 Mammals

Information reported in this section is based on reports submitted to the Applicant by Long (1974a,b,c, 1975), Wunderlin and Long (1975a,b), Wunderlin et al. (1977), and Stone & Webster Engineering Corporation (1972). The Stone & Webster mammal surveys (Table 5-35) were conducted from late April through May, 1972. The Long and Wunderlin studies (Tables 5-36 and 5-37) were conducted from March 15, 1974 through May 31, 1975, and additional studies occurred from August 1 through October 31, 1977. Information from the Beacon Key site (herein used as comparative data) was collected from March 1974 through February 1975. Supplementary regional information was taken from Layne et al. (1977).

Forty-five species of terrestrial mammals have ranges that include the Big Bend site, and 42 of these have been documented in Hillsborough County (Table 2-18). Only the coyote, black bear, and Florida panther have not been positively verified in the county. Two other species (i.e., southeastern shrew and the jaguarundi) have been reported in the county, but the records are questionable (Layne et al. 1977).

The 42 mammals recorded for Hillsborough County were reported in approximately 30 different habitats (Layne et al. 1977). Twelve habitats were surveyed on the Big Bend site. Only three major vegetation types (i.e., coastal strand, mangrove swamp forest, and pine flatwoods) occur on the site. Mammals found on the site are characteristic of lowland communities. Because of habitat differences, less diversity of mammalian species is expected onsite than in the rest of Hillsborough County and in the west-central part of Florida.

As many as 12 major habitats occur on the Big Bend site. These habitats range from relatively undisturbed native vegetation (e.g., mangrove swamp; typical flatwoods; and dunes, beaches, and flats), to highly disturbed areas (e.g., pasture and croplands, urban areas, and artificial barren lands).

Typical flatwoods and pastures/croplands have the greatest potential species diversity of any habitats occurring on the Big Bend site (29 and 28 species, respectively).

Of the 43 species of terrestrial mammals reported in Hillsborough County, 10 are not expected on the site because the site is near the periphery of their range. These include 3 species of bats, 3 species of mice, the round-tailed muskrat, nutria, coyote, and black bear. Not one of these species has been reported on the site.

5.2.4.2.3.1 Small Mammals

Two species of shrews, 1 species of mole, 11 species of rats and mice, and the pocket gopher could occur on or near the Big Bend site (Table 2-18). The old-field mouse, Florida mouse, and golden mouse are not expected to occur on the site because of range and/or habitat limitations. The Florida mouse is restricted to a sand pine-scrub habitat not found onsite. The old-field mouse and golden mouse are not expected to occur onsite because of range restrictions. Nine of the 12 remaining species have been reported on the site. Of the 3 species not reported, the eastern harvest mouse and eastern wood rat are very rare or not expected in habitats on the Big Bend site. The southeastern pocket gopher, although not recorded on the site, could occur in the well-drained, sandy soils that are sometimes found in the flatwoods, dry prairies, agricultural areas, and roadside shoulders. Its occurrence ranges from common to abundant in the region.

The hispid cotton rat was the most common small mammal captured at Big Bend and Beacon Key (Tables 5-35 and 5-36). It was captured least frequently in the mangroves and in the freshwater marshes. The marsh rice rat and house mouse were captured in nearly equal numbers at Big Bend. The house mouse was also common at Beacon Key. The black rat was common at Beacon Key but very uncommon at Big Bend, perhaps because of the distribution of the native vegetation. All other species were uncommon at both sites.

5.2.4.2.3.2 Bats

Eight species of bats could occur on or near the Big Bend site (Table 2-18). The southeastern myotis, eastern pipistrelle, and Rafinesque's big-eared bat reach the southern limits of their ranges near Hillsborough County, and they are not expected to occur on the Big Bend site. The southeastern myotis may be common in urban areas north of Hillsborough County. Rafinesque's big-eared bat utilizes hardwood hammocks north of this region but is considered rare throughout the state. The big brown bat is rare in the region. The most common and most widespread bat in the region is the northern yellow bat. In Polk, Hillsborough, Hardee, and Highlands Counties, the northern yellow bat comprised more than 52 percent of all bats captured during an intensive study by Jennings (1958). It usually occurs in wooded areas, especially those containing Spanish moss. The Brazilian free-tailed bat is the only other relatively common bat of the region. It is primarily associated with urban areas.

The northern yellow bat is the only species reported from the Big Bend site (Table 2-18). This species was reported by Stone & Webster Engineering Corporation (1972) in a cosmopolitan area. The evening bat is also expected on the site in typical flatwoods, and the Brazilian free-tailed bat is expected to forage over parts of the site.

5.2.4.2.3.3 Larger Mammals

Twenty-two species of larger mammals could occur on or near the Big Bend site (Table 2-18), and 19 of these have been reported in Hillsborough County. Although there are no definite records of the mountain lion (local subspecies known as Florida panther) and black bear from Hillsborough County, there are unconfirmed reports of both species near Beacon Key (Table 2-18). Although the coyote has not been reported in the county, its status is poorly defined in the state. It is not expected on the Big Bend site.

The gray squirrel, round-tailed muskrat, and nutria are near the limits of their range in the region, and their abundance on the site is probably low. The round-tailed muskrat and nutria generally occur in small, isolated populations in or near agricultural areas and water. The gray squirrel often occurs in urban areas but prefers deciduous stands of trees.

Of the remaining 16 species, the fox squirrel, southern flying squirrel, red fox, gray fox, and long-tailed weasel are generally rare or uncommon in the region.

The Virginia opossum is found in many habitats but is most common in typical flatwoods. The nine-banded armadillo also occurs in many habitats but is more common in drier areas. The eastern cottontail is more widespread and abundant in the region than the marsh rabbit, which is associated with freshwater marshes. The southern flying squirrel, like the gray and fox squirrels, is uncommon in the vicinity of the site because deciduous trees are scarce. Red and gray foxes are uncommon in highly disturbed areas, although they could occur in cropland. The raccoon is the most widespread and abundant large mammal of the region. Regionally, the spotted skunk is common in drier terrestrial habitats, while the striped skunk is more common in wooded and agricultural areas. In the more remote, undisturbed areas of Hillsborough County, river otters are common in some freshwater habitats, and they are also found in coastal bays and estuaries. Bobcats are also relatively common in undisturbed terrestrial habitats. The wild boar and white-tailed deer occur in Hillsborough County. They are game animals. However, their ranges are somewhat restricted by their preference for undisturbed habitats, and therefore they are local in occurrence. Neither species is expected on the Big Bend site.

Of the 22 species of large mammals that could occur on the Big Bend site, 9 have been reported. Long (1975) reported 8 species at Beacon Key (Table 2-18). The river otter and bobcat, species that are associated with somewhat large, undisturbed natural areas, were found at Beacon Key but not at the Big Bend site. They probably do not occur at Big Bend because of human disturbance and a lack of suitable habitat.

Seven species of large mammals were reported on the Big Bend site by Stone & Webster Engineering Corporation (1972). Three species (i.e., gray squirrel, eastern spotted skunk, and striped skunk) were not reported by Long and Wunderlin in 1974, 1975, or 1977. These species may have been onsite during these later studies, but they may have gone undetected because of their crepuscular and/or nocturnal habits.

Long and Wunderlin reported 6 species of large mammals on the Big Bend site (Table 5-36). Three of these were common and widespread onsite. The Virginia opossum and raccoon were recorded in 8 of 12 habitats. Although raccoons were common, they were not nearly as abundant as they were reported to have been in other parts of west-central Florida (Layne et al. 1977). Opossums were common in many areas. The nine-banded armadillo occurred in 5 habitats and was detected regularly in drier areas.

Both marsh rabbits and eastern cottontails occur on the Big Bend site. The cottontail was reported in 11 of 12 habitats on the Big Bend site. The eastern cottontail is one of the more common mammals on the site and in the region.

5.2.4.2.3.4 Discussion

Of the 45 species of terrestrial mammals whose geographic ranges include Big Bend, 19 were identified onsite during surveys in 1972, 1974, 1975, and 1977 (Table 2-18). Fifteen species were identified by Stone & Webster Engineering Corporation in 1972 (Table 5-35), and Long and Wunderlin identified 13 species in 1974, 1975, and 1977 (Table 5-36). Stone & Webster Engineering Corporation (1972) reported 6 species (i.e., least shrew, northern yellow bat, cotton mouse, gray squirrel, eastern spotted skunk, and the striped skunk) that were not found by Long and Wunderlin in 1974, 1975, or 1977. Long and Wunderlin reported 4 species (i.e., eastern mole, eastern cottontail, Norway rat, and gray fox) not reported by Stone & Webster. Six fewer species were reported by Wunderlin (after construction) than by Stone & Webster (before construction).

Long (1975) reported 17 species of mammals from Beacon Key, 10 miles south of the Big Bend site (Table 2-18). In addition, he cited unconfirmed reports of the Florida panther and black bear in the area. If these reports were accurate, those individuals would most likely have been transients, since no resident population of either species has been reported from the relatively undisturbed Beacon Key area. Four species (i.e., old-field mouse, eastern wood rat, river otter, and bobcat) were reported at Beacon Key but were not found by Long and Wunderlin at Big Bend. The old-field mouse is near the periphery of its range in the region, and its occurrence may be localized. The eastern woodrat was found in a hardwood hammock at Beacon Key, a habitat not found at Big Bend. The river otter and bobcat were regularly noted at Beacon Key but absent from Big Bend. These species prefer habitats that are relatively undisturbed as is most of the Beacon Key site. It is unlikely that these species would occur now on the Big Bend site.

5.2.4.2.3.5 Summary

Forty-five species of terrestrial mammals have geographic ranges that include the Big Bend site. At least 10 species are near their geographic range limits in the vicinity of the site; if they occur onsite, their abundance is probably low. Several other species (e.g., fox squirrel, eastern wood rat, red fox, bobcat, and river otter) are rare in the vicinity of the site and are not expected to occur onsite because suitable habitat is not available.

Nineteen species of mammals have been reported on the Big Bend site. Long (1975) reported 17 species at Beacon Key. Only 4 of them (i.e., old-field mouse, eastern wood rat, river otter, and bobcat) were not reported at the Big Bend site. These species would not be expected to occur at Big Bend because of insufficient habitat.

The hispid cotton rat is the most widespread and abundant small mammal on the site. It was reported in every habitat sampled. The marsh rice rat and house mouse were also relatively common. The northern yellow bat is probably the most common bat in the region and onsite. The raccoon, Virginia opossum, and cottontail are the most common large mammals on the site and they are found in a variety of habitats. No large game mammals (e.g., white-tailed deer and wild boar) are believed to occur on the site. The mountain lion (Florida panther) is the only regional mammal (except for the Florida or West Indian Manatee (Section 5.3.4.6.1)) on the Federal list of endangered species (44 FR 12, 3,636-3,654). It has not been authoritatively reported in Hillsborough County but several unconfirmed reports exist. It is not expected on the site. Two other species (i.e., bobcat and river otter) are under review by the

Federal Government for special-status listing, but neither is expected to occur on the Big Bend site because of habitat restrictions.

No terrestrial species of special status, as listed by the FGFWFC, is expected on the Big Bend site.

Nine special-status terrestrial species are listed by the FCREPA (Layne 1978). Only the big brown bat (rare), Rafinesque's big-eared bat (rare), and long-tailed weasel (rare) would have any chance of occurring on the site. All three species are considered rare in the region.

5.2.4.2.4 Game Species and Furbearers

Important game species whose geographic ranges include the site are listed in Table 5-38. Hunting and trapping of game species or furbearers is unimportant commercially or recreationally on the Big Bend site. Leg-hold traps are illegal in Florida and furbearing species may be taken only in live traps or by gun. Hunting on the site is probably minimal because of intensive agricultural and industrial development. The Hillsborough Wildlife Management Area (WMA) is the only FGFWFC management area in Hillsborough County. It occurs in the northern part of the county and is not near the Big Bend site. Two wildlife management areas occur in the region (i.e., Green Swamp WMA in Polk and Lake Counties and Cecil Webb WMA in Charlotte County). Game or furbearing species hunted there include bobwhite, mourning dove, common snipe, American woodcock, squirrel, raccoon, cottontail, bobcat, wild boar, and white-tailed deer.

5.2.4.2.4.1 Amphibians and Reptiles

Frogs are considered game species by the FGFWFC and can be taken throughout the year. They are not expected to be common at Big Bend.

All turtles occurring on the Big Bend site are classified as game species. Only the gopher tortoise, Suwanee cooter, and alligator snapping turtle have designated seasons and bag limits. Turtles are probably uncommon on the site.

5.2.4.2.4.2 Upland Game Birds and Waterfowl

Approximately 24 species of birds that are considered game species in Florida have ranges that include the Big Bend site (Table 5-33). The wild turkey, however, does not occur at Big Bend. The mourning dove is the only upland game bird regularly occurring at Big Bend, and it is probably the most abundant game species on the site. Bobwhite may occur on the site in small numbers. Waterfowl may also be important in saltwater areas near the Big Bend site. Although 20 species of waterfowl could occur near the site, only two (lesser scaup and ring-necked duck) are important game species in the southeastern parts of Tampa Bay (B. Towry, Florida Game and Fresh Water Fish Commission, personal communication, 1979). On a statewide basis, blue-winged teal, green-winged teal, and pintail are the most commonly taken dabbling ducks, whereas the lesser scaup, ring-necked duck, and hooded merganser are the most commonly taken diving ducks (U.S. Department of the Interior 1975). Diving ducks should be more common at Big Bend than dabbling ducks.

5.2.4.2.4.3 Mammals

Although seven species of game mammals have ranges that include the Big Bend site, only four are expected on or near the site. White-tailed deer, wild boar, and black bear, all of which occur in certain parts of west-central Florida, do not occur on the Big Bend site because suitable habitat is lacking. The presence of gray and fox squirrels on the site is limited by the scarcity of deciduous trees. Both marsh rabbits and eastern cottontails occur on the site, the latter occurring in almost every habitat.

Furbearing mammals of Florida are divided into three classes. Class A furbearers can be hunted or trapped (live traps only) the entire year. Of the six Class A furbearers potentially occurring on the site, only four (i.e., raccoon, opossum, striped skunk, and spotted skunk) are expected on the site and only the raccoon may be abundant enough for hunting or trapping.

The ranges of four Class B furbearers, those with restricted season and bag limits, include the site. Bobcat and river otter are not expected on the site because suitable habitat is lacking or because of the presence of man. Foxes could occur on the site, but they can only be pursued with dogs in Florida. Trapping, hunting and killing of foxes in Florida are prohibited.

Class C furbearers cannot be taken at any time. None is expected on the site, although the range of the Florida weasel and round-tailed muskrat include the site region.

5.2.4.2.4.4 Summary

Hunting or trapping is probably infrequent on the Big Bend site, primarily because few game or furbearing species occur on the site. Mourning dove, bobwhite, lesser scaup, ring-necked duck, eastern cottontail, and raccoon are probably the most common and important game or furbearing species occurring on or near the Big Bend site.

Table 5-19. Distribution of soils on the Big Bend site[a]

Soil designation	Map symbol[b]	Area (acres)	Coverage (percentage)
Adamsville fine sand	Aa	53.3	3.7
Bradenton fine sand	Bf	28.0	2.0
Delray fine sand, shallow phase	Db	3.6	1
Leon fine sand, light-colored surface phase	Lk	3.6	1
Made land	Ma	2.8	1
Ruskin fine sand	Rb	659.3	46.2
Shallow ponds with grass	Sc	28.9	2.0
Tidal marsh (unclassified soils)	Tb	94.0	6.6
Tidal swamp (unclassified soils)	Tc	122.9	8.6
Other[c]		431.0	30.2

[a] Adapted from U.S. Department of Agriculture (1958).
[b] Figure 5-14 shows the soil resources of the Big Bend site.
[c] Includes post-1958 man-made land and waterways (bay and canals).

Table 5-20. Limitations, restrictions, hazards, engineering properties, and adverse factors of soils belonging to revised soil associations found at the Tampa Electric Company site[a] (Sheet 1 of 2)

	Ruskin-Sunniland-Bradenton Association			Saltwater swamps and marshes association (saltwater, swampy marshes)	Ona-Scranton-Leon Association		
	Ruskin	Sunniland	Bradenton		Ona	Scranton	Leon
Degree of limitations, restrictions, and hazards							
Building construction (foundations for low buildings)	Severe, WT	Moderate, WT	Severe, WT	V severe, WT, FC, PBV	Severe, WT, Fl	Severe, WT	Severe, WT
Landscaping (lawns and ornamentals)	Moderate, WT	Severe, WT	Moderate, WT	V severe WT, Fl, Prod, Salinity	Moderate WT, Fl	Moderate WT, Fl	Moderate WT
Sanitation							
Sewage lagoons	Severe Perm	Severe Perm	Severe Perm	V severe Org, Fl	Severe Perm, WT	Severe Perm, WT	Severe Perm, WT
Septic tank filter fields	Severe WT	Severe WT	Severe WT	V severe WT, Fl	Severe WT, Fl	Severe WT, Fl	Severe WT, Fl
Transportation							
Highways, streets, paved parking	Moderate WT, Fl	Moderate WT	Moderate WT, Sh-Sw	V severe WT, Fl, TSC	Severe WT, Fl	Severe WT, Fl	Moderate WT, Fl
Dirt roads, unpaved streets and parking areas	Moderate Traf, WT, Fl	Moderate Traf, WT	Moderate Traf, WT	V severe Traf, WT, Fl	Severe WT, Fl	Severe WT, Fl	Moderate Traf, WT, Fl
Soil properties for engineering							
Flood hazard (frequency and duration)	Infrequent Brief	Infrequent Brief	Infrequent Brief	V frequent V long	Frequent Brief	Frequent Brief	Infrequent Brief
Water table seasonally high (depth and duration)	V shallow Brief	V shallow Brief	Shallow Brief	V shallow V long	V shallow Brief	V shallow Long	V shallow Brief
Percolation rate (min/in.)	45	45	45-75	Variable	45	45	45
Layer depth-subsequent engineering properties by depth (in.)	0-24 24-36 36-42	0-20 20-30 30-40+	0-22 22-32 32-42+	0-60	0-14 14-42+	0-14 14-42+	0-20 20-26 26-42+
Classification							
USDA texture	fs fscl marl	fs fscl marl	fs fscl fscl-fsc	Variable	fs fs	fs fs	fs fs fs
Unified	SM, SM-SP SC marl	SP SC	SP-SM SM-SC, SC SC	Variable	SM, SP-SM SP, SP-SM	SP-SM SP	SP SP-SM SP
AASHO	A-2 A-2, A-4	A-3 A-2-6	A-2 A-2, A-6 A-6	Variable	A-2 A-3	A-2 A-3	A-3 A-3, A-2 A-3
Permeability rate (in./h)	6.3 2.0-6.3	6.3 2.0-6.3	6.3 0.63-2.0 0.20-0.63	Variable	6.3 6.3	6.3 6.3	6.3 0.63-2.0 6.3

Note: See abbreviations and footnote at end of table.

Table 5-20. Limitations, restrictions, hazards, engineering properties, and adverse factors of soils belonging to revised soil associations found at the Tampa Electric Company site[a] (Sheet 2 of 2)

	Ruskin-Sunniland-Bradenton Association			Saltwater swamps and marshes association (saltwater, swampy marshes)	Ona-Scranton-Leon Association		
	Ruskin	Sunniland	Bradenton		Ona	Scranton	Leon
Soil properties for engineering (continued)							
Available water capacity (in./in.)	0.5 0.10–0.15	0.5 0.10–0.15	0.5–0.10 0.10–0.15 10–0.15	Saltwater swamps Variable	0.10–0.15 0.05–0.10	0.10–0.15 0.05–0.10	0.05 0.05–0.10 0.05
Shrink-swell potential	Low Moderate	Low Moderate	Low Moderate Moderate	Variable	Low Low	Low Low	Low Low Low
Soil factors adversely affecting							
Highway location	Periodic high WT	High WT, More at shallow depth	High WT, Moderate Sh-Sw	Tidal flooding	High WT	High WT	High WT
Excavated ponds	Loose sands	Moderate perm	Moderate to moderately slow perm	Tidal flooding	Unstable side slopes	Unstable side slopes	Unstable side slopes
Drainage	Unstable side slopes	Moderate perm	Moderate to slow perm	Low position, No outlet	Unstable side slopes	Unstable side slopes	Loose, erodible sands
Sprinkler irrigation	High WT	High WT	Moderate AWC	Tidal flooding	Moderate to low AWC	High WT	Low AWC
Subsurface irrigation	High WT	Moderate perm	Moderate AWC	Tidal flooding	Moderate to low AWC	None	Low AWC
Ditches and canals	Loose sand, surface layers	More at shallow depth	High WT	Tidal flooding	Unstable side slopes	Unstable side slopes	Loose sand, rapid perm
Sanitary landfill	Periodic high WT	Seasonal high WT	Seasonal high WT	Tidal flooding	Seasonal	Seasonal	Seasonal

Abbreviations:

AWC = available water capacity.
Fl = flood hazard.
fs = fine sand.
fsc = fine sandy clay.
fscl = fine sandy clay loam.
Org = organic.
PBV = presumptive bearing value.
Perm = permeability.
Prod = productivity.
Sh-Sw = shrink-swell.
SC = not defined in source document.
SM = not defined in source document.
SP = not defined in source document.
Traf = trafficability.
TSC = traffic support capacity.
V = very.
WT = water table.

[a] From U.S. Department of Agriculture (1969).

Table 5-21. Summary of priority considerations by selected nonagricultural soil-use categories[a]

Use category	Priority factors
Building construction (foundations for low buildings)	1. Presumptive bearing value 2. Shrink-swell behavior 3. Wetness 4. Permeability 5. Flood hazard
Lawns and ornamental plants	1. Flood hazard 2. Wetness 3. Productivity 4. Permeability 5. Available water capacity
Sanitation	
Septic tanks	1. Flood hazard 2. Wetness 3. Depth to bedrock 4. Permeability
Sewage lagoons	1. Permeability 2. Flood hazard 3. Depth to water table 4. Slope 5. Organic matter 6. Depth to bedrock
Transportation	
Highways, paved roads, parking areas	1. Flood hazard 2. Wetness 3. Traffic-supporting capacity 4. Depth to bedrock 5. Slope
Dirt roads, unpaved streets, parking areas	1. Flood hazard 2. Wetness 3. Trafficability

[a] From U.S. Department of Agriculture (1969).

Table 5-22. Degree and kinds of limitations and suitability ratings for soil associations found at the Tampa Electric Company site[a] (Sheet 1 of 2)

	Sunniland-Bradenton Association			Wetlands	
	Sunniland (40%)	Bradenton (30%)	Other (30%)	Saltwater swamp and marsh (75%)	Other (25%)
	Degree and kinds of limitations				
Sanitary Facilities					
Septic tank absorption fields	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding	Not rated
Sewage lagoons	Moderate, WT Seepage	Severe, WT Seepage	Not rated	V severe, WT, tidal flooding	Not rated
Sanitary landfills, trench type	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding	Not rated
Community development					
Shallow excavations	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding	Not rated
Dwellings	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding, low strength	Not rated
Light industry	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding, low strength	Not rated
Local roads and streets	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding,	Not rated
Water management					
Embankments, dikes, and levees	Slight	Slight	Not rated	Not rated	Not rated
Excavated ponds, aquifer-fed	Moderate, deep to water	Moderate, deep to water	Not rated	Slight	Not rated
Recreation					
Camps and picnic areas	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding	Not rated
Playgrounds	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding	Not rated
Paths and trails	Severe, WT	Severe, WT	Not rated	V severe, WT, tidal flooding	Not rated
	Soil features affecting water management				
Pond reservoir area	Seepage	Seepage	Not rated	Slope	Not rated
Drainage	WT	WT	Not rated	WT, poor outlets, tidal flooding	Not rated
Irrigation	WT	WT	Not rated	Tidal flooding, excessive fines, WT	Not rated

Note: See abbreviations and footnotes at end of table.

Table 5-22. Degree and kinds of limitations and suitability ratings for soil associations found at the Tampa Electric Company site[a] (Sheet 2 of 2)

	Sunniland-Bradenton Association			Wetlands	
	Sunniland (40%)	Bradenton (30%)	Other (30%)	Saltwater swamp and marsh (75%)	Other (25%)
	Suitability as a source of special materials				
Topsoil	Poor, too sandy	Poor, too sandy	Not rated	Not rated	Not rated
Sand	Poor, excess fines	Poor, excess fines	Not rated	Not rated	Not rated
Roadfill	Good	Good	Not rated	Not rated	Not rated
	Soil potential for agriculture				
Capability unit[b]	Class III w-10	Class III w-10	Not rated	Class VIII w-1	Not rated
Citrus	Moderate, WT	Moderate, WT	Not rated	V low, WT, tidal flooding	Not rated
Truck crops	High	High	Not rated	V low, WT, tidal flooding	Not rated
Improved pasture	High	High	Not rated	V low, WT, tidal flooding	Not rated
	Suitability as a habitat for wildlife				
Openland wildlife	Fair	Fair	Not rated	V poor	Not rated
Woodland wildlife	Fair	Fair	Not rated	V poor	Not rated
Wetland wildlife	Poor	Poor	Not rated	Good	Not rated

Abbreviations:
V = very.
WT = water table.

[a] From Florida Department of Administration (1975).

[b] Capability units are based on risk and potential response to management. High class numbers have high risk and low response potential.

Table 5-23. Vascular plants observed at Big Bend Station, March 1974 through May 1975[a] (Sheet 1 of 4)

Scientific name	Common name	Study sites[b]
Acalypha gracilens	Three-seeded mercury	3
Aeschynomene americana	Sensitive jointvetch	2, 4
Agalinis maritima	--	7
Amaranthus hybridus	Pigweed	3A, 4
Ambrosia artemisiifolia	Ragweed	1, 2, 3, 4, 8, 11, 12
Amorpha herbacea	Lead plant	8
Ampelopsis arborea	Pepper vine	4
Andropogon glomeratus	Beard grass	1, 2, 3, 3A, 4, 5, 8, 9, 12
Andropogon longiberbis	Beard grass	5, 8
Andropogon virginicus	Broom sedge	8
Aristida sp.	Wire grass	5
Aster subulatus var. *ligulatus*	--	1, 7, 9, 12
Aster tenuifolius	--	7
Avicennia germinans	Black mangrove	6, 7
Baccharis angustifolia	False willow	5, 8
Baccharis halimifolia	Saltbush	1, 2, 3, 3A, 4, 5, 9, 12
Bacopa cyclophylla	Water-hyssop	9, 10
Batis maritima	Salt wort	7
Bidens pilosa	Tickseed	1, 2, 3, 3A, 4, 11, 12
Borrichia frutescens	Sea daisies	7
Callicarpa americana	Beauty berry	11
Cassia aspera	Senna	2
Cassia fasciculata	Senna	4, 8, 12
Cenchrus echinata	Sandspur	1, 3A, 4
Centella asiatica	Coinwort	9
Chamaescyce hyssopifolia	Spurge	3, 3A, 12
Chenopodium ambrosioides	Goosefoot	1, 2, 4, 11
Chloris petraea	Finger grass	1, 2, 3A, 4, 5, 7, 12
Cladium jamaicense	Sawgrass	5
Commelina diffusa	Common day flower	2
Conocarpus erecta	Buttonwood	5
Conyza canadensis	Dwarf horsetail	1, 2, 3, 3A, 4, 12
Crotalaria mucronata	Rabbit bells	11
Crotalaria spectabilis	Rabbit bells	2, 4, 11, 12
Cynodon dactylon	Bermuda grass	2, 3A
Cyperus ligularis	Sedge	1, 3A, 4
Cyperus polystachyos	Sedge	1, 2, 3, 9, 10, 12
Cyperus rotundus	Nut grass	3, 3A

Note: See footnotes at end of table.

Table 5-23. Vascular plants observed at Big Bend Station, March 1974 through May 1975[a] (Sheet 2 of 4)

Scientific name	Common name	Study sites[b]
Cyperus surinamensis	Sedge	1, 2, 4, 9, 10 12
Cyperus tenuifolius	Sedge	2, 9
Desmodium canum	Tick clover	2, 4, 9, 12
Desmodium tortuosum	Tick clover	4
Desmodium triflorum	Tick clover	4
Dichromena colorata	White tops	9, 10
Digitaria adscendens	Crabgrass	1, 9
Digitaria sanguinalis	Crabgrass	3A, 4, 12
Diospyros virginiana	Persimmon	9
Distichilis spicata	Salt grass	3, 5, 7
Echinochla walteri	--	1
Eclipta alba	--	1, 12
Eleusine indica	Goose grass	1, 3, 4, 9, 12
Erechtites hieracifolia	Fireweed	8
Erianthus giganteus	Plumegrass	8
Eryngium baldwinii	Button snakeroot	8
Eupatorium compositifolium	Dog fennel	1, 2, 3, 3A, 4, 9, 11, 12
Fimbristylis castanea	Fringe rush	7, 8, 9
Galactia elliottii	Milk pea	3A, 4, 5, 8
Gaura angustifolia	Southern guara	4, 8
Geranium carolinianum	Cranesbill	4
Gnaphalium purpureum	Cudweed	8
Hedyotis procumbens	Innocence	8
Helenium amarum	Spanish daisy	3, 3A, 11
Heterotheca subaxillaris	Golden aster	1, 3A, 12
Hydrocotyle umbellata	Water pennywort	9, 10
Hymenocallis palmeri	--	5, 10
Hypericum cistitolium	St. John's wort	5, 8
Indigofera hirsuta	Indigo bush	2, 3, 3A, 4, 12
Ipomoea trichocarpa	Morning glory	2
Iva frutescens	Marsh elder	3, 3A, 5
Juncus roemerianus	Black rush	5, 7, 8, 10
Lachnocaulon anceps	Bog buttons	8
Laguncularia racemosa	White mangrove	6
Lantana camera	Shrub verbena	9, 11
Lepidium virginicum	Pepper grass	2, 4, 12
Leptochloa uninervia	Springletop	1
Linaria canadensis	Toadflax	3A, 4, 12
Lippia nodiflora	Frogbit	1, 2, 3, 4, 9, 10, 11, 12
Lobelia feayana	Bay lobelia	8

Note: See footnotes at end of table.

Table 5-23. Vascular plants observed at Big Bend Station, March 1974 through May 1975[a] (Sheet 3 of 4)

Scientific name	Common name	Study sites[b]
Ludwigia octovalvis	Water purslane	2, 3, 5, 8, 10, 12
Ludwigia peruviana	Water purslane	3A, 4, 12
Lythrum alatum var. *lanceolatum*	Loorestrife	1, 2, 3, 12
Medicago lupulina	Black medic	4
Melilotus alba	Sweet clover	1, 3A
Melothria pendula	Creeping cucumber	3, 4, 11
Mikania scandens	Climbing hempweed	8
Moathocloe littoralis	Shore grass	7
Musa sapientum	Banana	4
Myrica cerifera	Wax myrtle	4, 8, 9, 12
Myrica pusilla	Dwarf wax myrtle	8
Oenothera laciniata	Evening primrose	3A, 12
Oxalis dillenii	Yellow sorrel	8
Panicum breve	Panic grass	8
Panicum purpureum	Panic grass	3, 3A, 4
Panicum virgatus	Switchgrass	8
Parthenocissus quinquefolia	Virginia creeper	3, 4, 11
Paspalum notatum	Bahiagrass	2, 4, 9
Paspalum urvillei	Vasey grass	1, 2, 3, 3A, 4, 9, 12
Paspalum vaginatum	Seashore paspalum	3
Passiflora suberosa	Passion vine	4
Philoxerus vermicularis	Saltweed	7
Physalis angustifolia	Ground cherry	1, 3, 4, 9, 11
Pinus elliottii	Slash pine	8
Pluchea purpurascens	Marsh fleabane	1, 3, 4, 10, 12
Pluchea rosea	Marsh fleabane	3A, 5, 8, 9
Polygala gradiflora	Candyroot	4
Polygonum punctatum	Smart weed	10
Polypremum procoumbens		12
Portulaca oleracea	Purslane	3, 12
Portulaca pilosa	Rose purslane	1, 11, 12
Psidium guajavae	Guava	4
Quercus pumila	Running oak	8
Quercus virginiana	Live oak	5
Rhizophora mangle	Red mangrove	6
Rhuscopallina	Sumac	8
Rhynchelytrum roseum	Natal grass	1, 3A, 4
Rhychospora divergens	Sedge	8
Rubus trivialis	Dewberry	3A, 4, 5, 8, 9, 11
Sabal palmetto	Cabbage palm	5, 8
Sagittaria graminea	Arrow head	10
Salicornia virginica	Glass wort	7

Note: See footnotes at end of table.

Table 5-23. Vascular plants observed at Big Bend Station, March 1974 through May 1975[a] (Sheet 4 of 4)

Scientific name	Common name	Study sites[b]
Salix Caroliniana	Carolina willow	4
Sambucus simpsonii	Elderberry	2, 3A, 4
Samolus ebracteatus	Pimpernel	5, 8
Samolus parviflorus	Pineland pimpernel	8
Schinus terebithefolius	Brazilian pepper	3, 3A, 4, 5, 8, 9, 12
Schrankia microphylla	Sensitive briar	12
Scoparia dulcis	Sweet broom	5, 8, 12
Scutellaria integrifolia	Skull cap	8
Seronoa repens	Saw palmetto	5, 8
Sesbania exaltata	Sesban	1, 3
Sesuvium portulacastrum	Sea purslane	7
Setaria geniculata	Bristly foxtail	1, 3, 4, 9, 12
Sida acuta	Sida	3A, 4, 9
Sida rhombifolia		4
Smilax auriculata	Cat briar	8
Smilax bon-nox	Cat briar	8
Smilax laurifolia	Cat briar	5, 8
Solanum americanum	Nightshade	11, 12
Solidago chapmannii	Goldenrod	8
Solidago microcephala	Goldenrod	1, 3, 3A, 4, 5, 8, 8, 11, 12
Solidago sempervirens var. *mexicana*	Goldenrod	1, 2, 3, 3A, 5, 7, 8, 9, 11, 12
Sonchus asper	Sow thistle	2, 3A, 12
Spartina bakeri	Cordgrass	5, 7, 8, 10
Spartina spartinae	Cordgrass	7
Sporobolus dominegensis	Dropseed	1, 3A, 4, 12
Stenotaphrum secundatum	St. Augustine grass	4, 12
Teucrium canadense	Wood sage	4
Tillandsia recurvata	Ball moss	11
Tillandsia usineoides	Spanish moss	11
Toxicodendron radicans	Poison ivy	4, 5, 8
Tripsacum dactyloides	Gama grass	4, 5
Typa latifolia	Cattail	1, 2, 3A, 4, 10
Urena lobata	Caesar weed	2
Vaccinium myrsinites	Blueberry	8
Verbesina laciniata	Crownbeard	4, 5, 8
Vigna luteola	Cowpea	1, 3, 4, 7, 12
Vitis aestivalis	Southern grape	4
Vitis rotundifolia	Wild grape	4, 8, 9, 11

[a] From Wunderlin et al. (1975).

[b] Study sites are shown in Figure 5-15.

Table 5-24. Vegetational analysis of Big Bend Station, First Quarterly Report, 1974[a] (Sheet 1 of 2)

Scientific name	Common name	No. of quadrats species occurred in	No. of trees, shrubs, herbs, etc.	Density		Frequency	Importance value	Average D.B.H.	Percent cover
				No./acre	No./m²				
Study Site 8[b]									
Serena repens	Saw palmetto	6	689	4,593		100	144		95
Myrica cerifera	Wax myrtle	6	262	1,746		100	59		16
Baccharis halimifolia	Salt bush	6	103	686		100	34		6
Vaccinium myrsinetes	Shiny blueberry	4	38	253		67	17		0.7
Rhuscopallina	Sumac	4	55	366		67	19		1
Myrica pusilla	Dwarf wax myrtle	4	20	133		67	15		0.2
Sabal palmetto	Cabbage palm	6	12	80		100	26	9.7	0.17
Schinus terebinthifolius	Brazilian pepper	6	9	60		67	14		0.5
Toxicodendron radicans	Poison ivy	2	2	13		33	7		0.5
Pinus elliottii var. *elliottii*	Slash pine	1	1	6.7		17	6	9.7	11
Quercus pumila	Running oak	2	2	13		33	7		0.008
Vitis rotundifolia	Muscadine grape	1	4	27		17	6		0.9
Smilax bona-nox	Catbrier	1	1	6.7		17	3		0.16
Smilax auriculata	Greenbrier	1	1	6.7		17	3		0.06
Study Site 2[c]									
Solidago microcephala	Goldenrod	41	196	3.3	13,060	68			1.4
Solidago sempervirens var. *mexicana*	Goldenrod	15	88	1.5	5,866	25			3.6
Spartina bakeri	Cordgrass	12	13	0.22	867	20			6.4
Rhynchospora divergens	Sedge	8	14	0.23	933	13			0.3
Pluchea rosea	Camphor weed	9	11	0.18	733	15			0.12
Lachnocaulon anceps	Bogbutton	7	13	0.22	867	12			0.06
Scutellaria integrifolia	Skullcap	19	54	0.9	3,600	32			0.3
Hedyotis procumbens	Innocence	17	39	0.65	2,600	28			0.2
Panicum virgatus	Panic grass	11	42	17	2,800	18			0.5
Mikania scandens		2	2	0.03	0.33	3			0.07
Erianthus giganteus	Plumegrass	2	2	0.03	0.33	3			0.4
Galactia elliottii	Milk pea	22	141	235	9,400	36			2.3
Erechtes hieracifolia	Fireweed	2	2	0.03	0.33	3			0.07
Eryngium baldwinii	Button snakeroot	1	1	0.017	66	1.7			0.1
Panicum breve	Panic grass	12	73	4,867	1.2	20			0.1
Gnaphalium obtusifolium	Rabbit tobacco	2	5	0.08	333	3			0.003
Gnaphalium purpureum	Rabbit tobacco	3	4	0.07	266	5			0.01
Ambrosia artemisiifolia	Ragweed	1	1	0.017	66	1.7			0.006
Samolus parviflorus	Water pimpernel	4	4	0.07	266	6.7			0.03
Juncus roemerianus	Blackrush	7	12	0.2	1,066	1.7			0.5
Lobelia feayana	Bay lobelia	1	1	0.017	60	1.7			0.09
Fimbristylis castanea	Fringerush	7	15	0.15	600	11.7			0.7
Scoparia dulcis	Sweet broom	1	1	0.017	66	1.7			0.01
Oxalis dillenii	Yellow sorrel	4	5	0.08	333	6.7			0.12

Note: See abbreviation and footnotes at end of table.

Table 5-24. Vegetational analysis of Big Bend Station, First Quarterly Report, 1974[a] (Sheet 2 of 2)

Scientific name	Common name	No. of quadrats species occurred in	No. of trees, shrubs, herbs, etc.	Density No./acre	Density No./m²	Frequency	Importance value	Average D.B.H.	Percent cover
Study Site 5[d]									
Baccharis angustifolia	False willow	2	18	1,500		100	73		22
Baccharis halimifolia	Saltbush	2	23	1,917		100	72		9.7
Conocarpus erecta	Buttonwood	1	2	166		50	12.3		6
Iva frutescens	Marsh elder	2	13	1,083		100	56		16
Schinus terebinthifolius	Brazilian pepper	1	1	83		50	7.3		0.6
Sabal palmetto	Cabbage palm	1	1	83		50	16.2	7	26
Toxicodendron radicans	Poison ivy	1	9	750		50	22		0.9
Serenoa repens	Saw palmetto	1	5	417		50	27		1.2
Study Site 11[e]									
Spartina bakeri	Cordgrass	8	11	1.1	4,400	80			65
Juncus roemerianus	Blackrush	8	45	4.5	18,000	80			16
Solidago sempervirens var. *mexicana*	Goldenrod	7	104	10.4	41,600	70			65
Samolus ebracteatus	Water pimpernel	2	3	0.3	1,200	20			0.5
Distichilis spicata	Saltgrass	3	14	1.4	5,600	30			1.7
Hymenocallis palmeri		1	2	0.2	800	10			0.5
Study Site 7[f]									
Borrichia frutescens	Sea daisies	2	735	49	183,750	13			6.5
Sesuvium portulacastrum	Sea purslane	11	73	4.87	18,250	73			6.2
Monanthocloe littoralis	Saltgrass	10	2,330	155.3	582,500	67			27.8
Distichilis spicata	Saltgrass	10	4,244	283	1,061,000	67			35.5
Avicennia germinans	Black mangrove	1	2	0.13	500	6.7			8.1
Batis maritima	Saltwort	6	93	6.2	23,250	27			6.5
Salicornia virginica	Glasswort	4	300	20	75,000	27			4.2
Open space			0						8.9
Spartina bakeri	Cordgrass	8	11	1.1	4,400	80			65
Juncus roemerianus	Blackrush	8	45	4.5	18,000	80			16
Solidago sempervirens var. *mexicana*	Goldenrod	7	104	10.6	41,600	70			65
Samolus ebracteatus	Water pimpernel	2	3	0.3	1,200	20			0.5
Distichilis spicata	Saltgrass	3	14	1.4	5,600	30			1.7
Hymenocallis palmeri		1	2	0.2	800	10			0.5
Study Site 6[g]									
Laguncularia racemosa	White mangrove	6	201	3,350		80	79	0.9	13
Avicennia germinans	Black mangrove	5	484	8,067		100	166	1.9	46
Rhizophora mangle	Red mangrove	3	71	1,183		60	54	1.3	34

Abbreviation: D.B.H. = diameter at breast height.

[a] From Long (1974a).

[b] Vegetation type: Sabal-Serenoa-Pinus scrub.
Quadrat size: 100 m² (6 analyzed).

[c] Vegetation type: Herbaceous.
Quadrat size: 1 m² (60 analyzed).

[d] Vegetation type: Transition between 2 and 11; woody.
Quadrat size: 25 m² (2 analyzed).

[e] Vegetation type: Transition between 2 and 11; herbaceous.
Quadrat size: 1 m² (10 analyzed).

[f] Vegetation type: Salt flat.
Quadrat size: 1 m² (15 analyzed).

[g] Vegetation type: Mangroves.
Quadrat size: 50 m² (5 analyzed).

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 1 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 1[b]				
Sporobolus domingensis	Dropseed	0.59	1.41	3.5	11.5	6.89	4.06	22.45
Sesbania exaltata	Sesban	0.32	1.59	19.5	6.24	7.77	22.62	36.63
Chloris petraea	Finger grass	0.54	2.32	4.5	10.53	11.34	5.22	27.09
Vigna luteola	Cow pea	0.73	2.6	25.5	14.23	12.71	29.58	56.52
Digitaria adscendens	Crabgrass	0.09	0.09	4.0	1.75	0.44	4.64	6.83
Rhynchelytrum roseum	Red top	0.32	0.73	3.5	5.24	3.57	4.06	13.87
Typha sp.	Cattail	0.04	0.41	0.5	0.78	2.0	0.58	3.36
Solidago sempervirens var. *mexicana*	Goldenrod	0.36	1.68	7.5	7.08	8.21	8.7	23.99
Cyperus ligularis	Sedge	0.09	0.09	0.5	1.75	0.44	0.48	2.77
Andropogan glomeratus	Beard grass	0.23	0.64	1.0	4.48	8.13	1.16	8.77
Paspalum urvillei	Vasey grass	0.22	0.86	0.5	4.29	4.20	0.58	9.07
Leptochloa uninervia	Sprangletop	0.04	0.27	3.0	0.78	1.32	3.48	5.58
Setaria geniculata	Bristly foxtail	0.04	0.23	0.5	0.78	1.24	0.58	2.6
Eupatorium sp.	Dog fennel	0.41	3.54	2.7	7.99	17.3	3.13	28.42
Heterotheca subaxillaris	Camphor weed	0.14	0.36	3.0	2.73	1.76	3.48	7.97
Echinochloa walterii		0.04	0.04	trace	0.78	0.19	--	0.97

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 2 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 1[b] (continued)					
Lythrum alatum var. *laceolatum*	Loosestrife	0.09	0.14	trace	1.75	0.68	--	2.43
Pluchea purpurascens	Marsh fleabane	0.04	0.14	trace	0.78	0.68	--	1.46
Cyperus polystachyos	Sedge	0.09	0.14	trace	1.75	0.68	--	2.43
Cyperus surinamensis	Sedge	0.04	0.04	trace	0.78	0.19	--	0.97
Cenchrus echinata	Sandspur	0.09	0.09	1.0	1.75	0.44	1.16	3.35
Baccharis halimifolia	Saltbush	0.23	2.5	3.0	4.48	12.22	3.48	20.18
Portulaca pilosa	Rose purslane	0.04	0.14	1.0	0.78	0.68	1.16	2.62
Bidens pilosa	Tickseed	0.09	0.14	trace	1.75	0.68	--	2.43
Ambrosia artemisiifolia	Ragweed	0.04	0.04	0.5	0.78	0.19	--	0.97
Phytolacca americana	Pokeweed	0.04	0.04	0.5	0.78	0.19	0.58	1.55
Eleusine indica	Goose grass	0.14	0.18	1.0	2.73	0.88	1.16	4.77
			Study Site 2[c]					
Ludwigia octovalvis	Water purslane	0.31	1.21	5.0	4.49	1.67	3.06	9.22
Andropogon glomeratus	Beard grass	0.21	0.26	0.5	3.04	0.36	0.30	3.7
Lepidium virginicum	Peppergrass	0.21	0.47	trace	3.04	0.65	--	3.69

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 3 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 2[c] (continued)					
Baccharis halimifolia	Saltbush	0.37	0.96	1.0	5.36	1.32	0.61	7.29
Commelina diffusa	Common day flower	0.42	2.89	5.0	6.09	3.98	3.06	13.13
Cynodon dactylon	Bermuda grass	0.89	39.58	87.0	12.90	54.52	53.21	120.63
Urena lobata	Caesar weed	0.05	0.05	0.5	0.72	0.07	0.3	1.09
Bidens pilosa	Tickseed	0.63	7.68	12.0	9.13	10.58	7.33	27.04
Cassia aspera	Senna	0.53	3.05	13.0	7.68	4.20	7.95	19.83
Indigofera hirsuta	Indigo bush	0.53	2.00	4.0	7.68	2.75	2.45	12.88
Eupatorium sp.	Dog fennel	0.68	5.68	9.5	9.85	7.82	5.81	23.48
Crotalaria spectabilis	Rabbit bells	0.05	0.05	trace	0.72	0.07	--	0.79
Paspalum urvillei	Vasey grass	0.1	0.10	1.0	1.45	0.14	0.61	2.2
Cyperus polystachyos	Sedge	0.3	1.21	1.0	4.35	0.43	0.61	5.37
Ambrosia artemisiifolia	Ragweed	0.37	2.58	15.5	5.36	3.71	9.48	18.39
Ipomea sp.	Morning glory	0.42	0.53	5.5	6.09	0.76	3.36	10.18
Conyza canadensis	Dwarf horseweed	0.21	0.42	trace	3.04	0.60	--	3.62
Cyperus surinamensis	Sedge	0.21	0.37	trace	3.04	0.53	--	3.55
Chenopodium ambrosioides	Goosefoot	0.05	0.05	trace	0.72	0.07	--	0.79
Cyperus tenuifolius	Sedge	0.21	2.37	1.0	3.04	3.41	0.61	6.91

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 4 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 2[c] (continued)				
Sambucus simpsonii	Elderberry	0.05	0.89	1.0	0.72	1.28	0.61	2.55
Lippia nodiflora	Frogbit	0.05	0.10	1.0	0.72	0.14	0.61	1.47
Solidago sempervirens var. mexicana	Goldenrod	0.05	0.10	trace	0.72	0.14	--	0.86
				Study Site 3[d]				
Ludwigia octovalvis	Water purslane	0.04	0.04	0.5	0.73	0.07	0.70	1.5
Baccharis halimifolia	Saltbush	0.33	0.96	3.0	6.05	1.77	4.19	12.01
Solidago sempervirens var. mexicana	Goldenrod	0.79	13.75	12.0	14.49	25.33	16.78	56.60
Melothria pendula var. pendula	Creeping cucumber	0.21	0.33	1.0	3.85	0.61	1.40	5.86
Distichilis spicata	Salt grass	0.17	2.46	1.0	3.12	4.53	1.40	9.05
Eupatorium sp.	Dog fennel	0.12	0.29	2.0	2.80	0.53	2.30	5.63
Panicum sp.	Panic grass	0.08	0.08	0.5	1.47	0.15	0.70	2.32
Paspalum vaginatum								
Iva frutescens	Marsh elder	0.17	1.4	4.0	3.12	2.58	5.59	11.29
Setaria geniculata	Bristly foxtails	0.21	0.54	5.5	3.85	0.99	7.69	12.53

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 5 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 3[d] (continued)								
Pluchea purpurascens	Marsh fleabane							
Chamaesyce hyssopifolia	Spurge	0.12	0.12	trace	2.20	0.22	--	2.42
Chloris petraea	Finger grass	0.33	0.58	4.5	6.05	1.07	6.29	13.41
Cyperus polystachyos	Sedge	0.17	0.71	1.5	3.12	1.30	2.10	6.52
Helenium amarum	Sneezeweed	0.12	0.12	1.0	2.20	0.22	1.40	3.82
Cyperus rotundus	Galingale	0.38	16.92	5.0	6.97	31.18	6.99	45.14
Parthenocissus quinquefolia	Virginia creeper	0.04	0.04	trace	0.73	0.07	--	0.80
Acalypha gracilens	Three-seeded mercury	0.04	0.04	0.5	0.73	0.07	0.70	1.5
Schinus terebinthefolius	Brazilian pepper	0.29	0.46	1.5	5.32	0.85	2.10	8.27
Pytolacca americana	Pokeweed	0.04	0.04	2.0	0.73	0.07	2.80	3.60
Indigofera hirsuta	Indigo bush	0.17	0.5	1.0	3.12	0.92	1.40	5.44
Paspalum urvillei	Vasey grass	0.04	0.04	trace	0.73	0.07	--	0.80
Ambrosia artemisiifolia	Ragweed	0.12	0.25	2.0	2.20	0.46	2.80	5.46
Andropogon sp.	Beard grass	0.08	0.08	trace	1.47	0.15	--	1.62
Vigna luteola	Cow pea	0.25	0.29	1.5	4.59	0.53	2.10	7.22
Typha sp.	Cattail	0.04	0.04	0.5	0.73	0.07	0.70	1.5
Sesbania exaltata	Sesban	0.12	0.12	4.5	2.20	0.22	6.29	8.71

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 6 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 3[d] (continued)				
Bidens pilosa	Tickseed	0.08	0.21	trace	1.47	0.39	--	1.86
Lythrum alatum var. *lanceolatum*	Loosestrife	0.04	0.04	1.5	0.73	0.07	2.10	2.90
Portulaca oleracea	Purslane	0.04	0.04	trace	0.73	0.07	--	0.80
Solidago microcephala	Goldenrod	0.21	8.92	12.5	3.85	16.43	17.48	37.76
Eluesine indica	Goose grass	0.04	0.04	trace	0.73	0.07	--	0.80
Lippia nodiflora	Frogbit	0.04	0.17	trace	0.73	0.31	--	1.04
Chamaesyce sp.	Spurge	0.04	0.04	trace	0.73	0.07	--	0.80
Conyza canadensis	Dwarf horseweed	0.04	0.04	trace	0.73	0.07	--	0.80
				Study Site 4[e]				
Sambucus simpsonii	Elderberry	0.55	0.42	14.0	15.49	34.43	31.85	81.77
Schinus terebinthefolius	Brazilian pepper	0.78	0.19	12.5	21.97	15.57	28.44	65.98
Myrica cerifera	Wax myrtle	0.89	0.25	5.0	25.07	20.49	11.38	56.94
Baccharis halimifolia	Saltbrush	0.67	0.22	5.5	18.87	18.03	12.51	49.41
Salix caroliniana		0.55	0.13	5.45	15.49	12.40	38.54	--
Musa sapientum		0.11	0.01	1.5	3.10	0.82	3.41	7.33
Parthenocissus quinquefolia	Virginia creeper	0.55	0.17	2.5	3.55	1.90	2.91	8.36

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 7 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 4[e] (continued)								
Ampelopsis arborea	Pepper vine	1.00	0.44	7.5	6.46	4.91	8.74	20.11
Verbesina laciniata	Crownbeard	0.78	0.71	8.0	5.04	7.92	9.32	22.28
Rhynchelytrum roseum	Red top	0.33	0.06	1.0	2.13	0.67	1.16	3.96
Bidens pilosa	Tickseed	1.00	0.67	6.0	6.46	7.48	6.99	20.93
Ambrosia artemisiifolia	Ragweed	1.00	0.97	11.5	6.46	10.82	13.39	30.67
Desmodium Canum	Tick clovers	0.33	0.06	trace	2.13	0.67	--	2.8
Desmodium triflorum	Tick clover	0.44	0.11	1.5	2.84	1.23	1.75	5.82
Psidium guajava	Guava	0.22	0.03	1.0	1.42	0.33	1.16	2.91
Teucrium canadense	Wood sage	0.33	0.16	0.75	2.13	1.78	0.87	4.78
Paspalum sp.		0.55	0.75	3.05	3.55	8.37	3.55	15.47
Galactia elliottii	Milk pea	0.67	0.24	2.5	4.33	2.68	2.91	9.92
Vitis rotundifolia	Muscadine grape	0.33	0.08	1.0	2.13	0.89	1.16	4.18
Rubus trivialis	Blackberry	1.00	0.32	5.5	6.46	3.57	6.41	16.44
Setaria geniculata	Bristly foxtail	0.55	0.14	0.5	3.55	1.56	0.58	5.69
Gaura angustifolia	Southern gaura	0.67	0.19	2.0	4.33	2.12	2.33	8.78
Toxicodendron radicans	Poison ivy	0.11	0.03	trace	0.71	0.44	--	1.04

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 8 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 4[e] (continued)					
Chenopodium ambrosioides	Goosefoot	0.33	0.22	3.0	2.13	2.45	3.49	8.07
Paspalum urvillei	Vasey grass	0.55	0.46	5.0	3.55	5.13	5.82	14.50
Sida rhombifolia		0.22	0.13	1.5	1.42	1.45	1.75	4.62
Sporobolus domingensis	Dropseed	0.44	0.46	1.5	2.84	5.13	1.75	9.72
Conyza canadensis	Dwarf horseweed	0.44	0.17	2.0	2.84	1.90	2.33	7.07
Vitis aestivalis	Southern grape	0.22	0.06	1.0	1.42	0.67	1.16	3.25
Melothria pendula var. *pendula*	Creeping cucumber	0.44	0.11	1.5	2.84	1.23	1.75	5.82
Cyperus ligularis	Sedge	0.11	0.02	trace	0.71	0.33	--	0.93
Lippia nodiflora	Frogbit	0.44	0.11	2.0	2.84	1.23	2.44	6.40
Digitaria sanguinalis	Crabgrass	0.22	0.92	2.5	1.42	10.27	2.91	14.6
Cenchrus echinata	Sandspur	0.11	0.14	0.5	0.71	1.56	0.58	1.85
Indigofera hirsuta	Indigo bush	0.22	0.05	trace	1.42	0.56	--	1.98
Solidago microcephala	Goldenrod	0.22	0.13	0.5	1.42	1.45	0.58	3.45
Passiflora suberosa	Passion vine	0.22	0.05	1.05	1.42	0.56	1.22	3.20

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 9 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 4[e] (continued)					
Phytolacca americana	Pokeweed	0.22	0.13	3.0	1.42	1.45	3.49	6.36
Chloris petreae	Finger grass	0.33	0.16	1.0	2.13	1.78	1.16	5.07
Lepidium virginicum	Peppergrass	0.33	0.09	2.0	2.13	1.00	2.33	5.46
Typha sp.	Cattail	0.22	0.28	3.0	1.42	3.12	3.49	8.03
Cassia fasciculata	Senna	0.33	0.14	0.5	2.13	1.56	0.58	4.27
			Study Site 5[f]					
Solidago sempervirens var. *mexicana*	Goldenrod	0.9	23.12	18.0	26.16	61.02	29.51	116.69
Solidago microcephala	Goldenrod	0.0	8.53	12.0	26.16	22.53	19.67	68.36
Juncus roemerianus	Black rush	0.53	3.1	16.5	16.41	8.10	27.05	50.65
Galactia elliottii	Milk pea	0.53	1.83	1.5	15.41	5.83	2.46	22.70
Aristida sp.	Wire grass	0.13	0.16	3.5	3.80	0.42	5.74	9.96
Cladium jamaicense	Sawgrass	0.1	0.3	2.5	2.91	0.79	5.74	9.44
Pluchea rosea	Marsh fleabane	0.06	0.13	0.5	1.74	0.34	0.82	2.9
Scoparia dulcis	Sweet broom	0.06	0.16	trace	1.74	0.42	--	2.16
Spartina bakeri	Cordgrass	0.23	0.53	5.5	6.69	1.40	9.02	17.11

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 10 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 5[f] (continued)					
Serenoa repens	Saw palmetto	1.0	0.4	17	18.80	47.61	36.17	102.58
Baccharis halimifolia	Saltbush	1.0	0.21	14	18.80	24.00	29.79	73.59
Quercus virginiana	Oak	1.0	0.10	1	18.80	11.90	2.13	32.83
Schinus terebinthefolius	Brazilian pepper	1.0	0.10	3	18.80	11.90	6.38	37.08
Sabal palmetto	Cabbage palm	0.66	0.02	7	12.41	2.38	14.89	29.68
Baccharis angustifolia	False willow	0.33	0.01	4	6.20	1.19	8.51	15.90
Iva frutescens	Marsh elder	0.33	0.003	1	6.20	0.36	2.13	8.69
			Study Site 88					
Solidago microcephala	Goldenrod	0.84	4.25	2.0	23.33	32.79	10.31	66.43
Solidago sempervirens var. mexicana	Goldenrod	0.31	2.16	3.8	8.61	16.67	19.60	44.88
Spartina bakeri	Cordgrass	0.16	0.16	6.19	4.44	1.23	31.92	37.59
Rhynchospora divergens	Sedge	0.06	0.06	0.2	1.67	0.46	1.03	3.16
Pluchea rosea	Marsh fleabane	0.03	0.03	trace	0.83	0.23	--	1.06
Lachnocaulon anceps	Bog button	0.13	0.22	trace	3.61	1.70	--	5.31
Hedyotis procumbens	Innocence	0.28	0.44	0.2	7.78	3.39	1.03	12.2
Panicum virgatus	Switchgrass	0.16	0.5	0.5	4.44	3.86	2.58	10.88

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 11 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 8[g] (continued)					
Mikania scandens		0.03	0.03	trace	0.83	0.23	--	1.06
Erianthus giganteus	Plumegrass	0.03	0.03	0.3	0.83	0.23	1.55	2.61
Galactia elliottii	Milk peas	0.53	2.69	2.5	15.72	20.76	12.89	48.37
Erechtites hieracifolia	Fireweed	0.03	0.03	trace	0.83	0.23	--	1.06
Panicum breve	Panic grass	0.13	0.81	0.2	3.61	6.25	1.03	10.89
Gnaphalium purpureaum	Cudweed	0.03	0.06	trace	0.83	0.46	--	1.29
Ambrosia artemisiifolia	Ragweed	0.03	0.06	trace	0.83	0.46	--	1.29
Cassia fasciculata	Senna	0.18	0.22	0.5	5.0	1.70	2.58	9.28
Samolus parviflorus	Pineland pimpernel	0.06	0.09	trace	1.67	0.69	--	2.36
Juncus roemerianus	Black rush	0.09	0.18	0.7	2.5	1.39	3.61	7.5
Fimbristylis castanea	Fringe rush	0.09	0.28	0.8	2.5	2.16	4.12	8.78
Scoparia dulcis	Sweet broom	0.09	0.13	0.5	2.5	1.0	2.58	6.08
Andropogon sp.	Beard grass	0.28	0.5	1.0	7.78	3.86	5.16	16.8
Oxalis dillenii	Yellow sorrel	0.03	0.03	trace	0.23	0.23	--	1.06
			Study Site 9[h]					
Hydrocotyle umbellata	Water pennywort	0.78	1.13	8.0	8.2	10.39	7.18	25.77

Note: See footnotes at end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 12 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 9[h] (continued)								
Digitaria adscendens	Crabgrasses	0.89	3.37	33.0	9.36	31.0	29.63	69.99
Desmodium canum	Tick clovers	0.89	0.88	14.0	9.3	8.09	12.57	30.02
Andropogon glomeratus		0.55	0.49	6.59	5.78	4.51	5.83	16.12
Dichromena colorata	White tops	0.33	0.33	1.32	3.47	3.03	1.18	7.68
Centella asiatica	Coin wort	1.0	0.8	13.0	10.51	7.36	11.67	29.54
Cyperus polyastchyos	Sedge	0.55	0.6	3.70	5.78	5.52	3.32	14.62
Bacopacyclophylla		0.33	0.2	2.50	3.47	1.84	2.24	7.55
Setaria geniculata	Knot root	0.55	0.27	1.50	5.78	2.40	1.35	9.61
Lippia nodiflora	Frogbit	0.55	0.27	4.0	5.78	2.48	3.59	11.85
Solidago sempervirens var. *mexicana*	Goldenrod	0.22	0.07	0.45	2.31	0.64	0.45	3.4
Fimbristylis castanea	Fringe rush	0.44	0.18	3.5	4.63	1.65	3.14	9.42
Cyperus surinamensis	Sedge	0.22	0.07	0.5	2.31	0.64	0.45	3.4
Cyperus tenuifolius	Sedge	0.55	1.42	7.5	5.78	13.06	6.74	25.58
Eupatorium sp.	Dog fennel	0.67	0.33	3.0	7.04	3.03	2.69	12.78
Vitis rotundifolia	Muscadine grape	0.11	0.02	0.5	1.16	0.18	0.45	1.79

Note: See footnotes at the end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 13 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 9[h] (continued)				
Rubus trivialis	Blackberry	0.22	0.09	3.5	2.31	0.83	3.14	6.28
Phytolacca americana	Pokeweed	0.11	0.02	1.0	1.16	0.18	0.90	2.24
Sida acuta		0.11	0.02	0.5	1.16	0.18	0.45	1.79
Diospyros virginiana	Persimmon	0.22	0.09	2.0	2.31	0.83	1.79	4.93
Solidago microcephala	Goldenrod	0.11	0.18	0.84	1.16	1.65	0.75	3.56
Paspalum urvillei	Vasey grass	0.11	0.04	0.34	1.16	0.37	0.31	1.84
Pinus elliottii var. *elliottii*	Splash pine	0.22	0.04	6.4	100	100	100	300
				Study Site 11[i]				
Myrica cerifera	Wax myrtle	0.4	0.03	22.5	16.67	23.08	33.09	72.84
Baccharis halimifolia	Saltbush	1.0	0.07	40	41.67	53.85	58.82	154.34
Schinus terebinthefolius	Brazilian pepper	0.6	0.02	3.5	25.00	15.38	5.15	45.53
Lantana camara	Shrub verbena	0.4	0.01	2.0	16.67	7.70	2.94	27.31
Solidago microcephala	Goldenrod	0.8	7.98	23.5	11.76	78.54	33.00	123.3
Crotalaria spectabilis	Rabbit bells	0.4	0.13	1.0	5.88	1.28	1.4	8.56
Parthenocissus quinquefolia	Virginia creeper	0.2	0.01	1.0	2.94	0.10	1.4	4.44
Solidago sempervirens var. *mexicana*	Goldenrod	0.4	0.08	1.0	5.88	0.79	1.4	8.07

Note: See footnotes at the end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 14 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 11[i] (continued)								
Lippia nodiflora	Frogbit	0.4	0.15	1.2	5.88	1.48	1.68	9.04
Rubus trivialis	Blackberry	1.0	1.0	37.0	14.7	9.84	51.97	76.51
Helenium amarum	Sneezeweed	0.2	0.02	trace	2.94	0.20	--	3.54
Eupatorium sp.	Dog fennel	0.4	0.09	1.0	5.88	0.88	1.4	8.16
Melothria pendula var. pendula	Trailing cucumber	0.6	0.08	1.0	8.82	0.79	1.4	11.01
Ambrosia artemisiifolia	Ragweed	0.4	0.38	1.5	5.88	3.74	2.11	11.73
Chenopodium ambrosioides	Goosefoot	0.2	0.02	trace	2.94	0.20	--	3.14
Phytolacca americana	Pokeweed	0.4	0.03	0.5	5.88	0.29	0.7	6.87
Vitis rotundifolia	Muscadine grape	0.2	0.02	0.5	2.94	0.2	0.7	3.84
Callicarpa americana	Beauty berry	0.2	0.01	1.5	2.94	0.1	2.11	5.0
Physalis angustifolia	Ground cherry	0.2	0.1	0.5	2.94	0.98	0.7	4.62
Tillandsia usineoides	Air plant	0.4	0.02	trace	5.88	0.2	--	6.08
Tillandsia recurvata	Air plant	0.4	0.04	trace	5.88	0.39	--	6.27

Note: See footnotes at the end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 15 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 12[j]					
Eupatorium sp.	Dog fennel	0.86	18.14	21	17.37	38.53	23.84	79.74
Lippia nodiflora	Frogbit	0.09	0.48	3	1.82	1.02	3.40	6.24
Ambrosia artemisiifolia	Ragweed	0.71	9.66	12	14.34	20.52	13.62	48.48
Oenothera laciniata	Evening primrose	0.38	2.09	1.5	7.68	4.44	1.70	13.82
Conyza canadensis	Dwarf horseweed	0.52	2.86	8	10.50	6.07	9.08	25.65
Ludwigia octovalvis	Water purslane	0.05	0.05	1	1.01	0.11	1.13	2.25
Ludwigia peruviana	Water purslane	0.05	0.05	0.5	1.01	0.11	0.57	1.69
Cyperus polystachyos	Sedge	0.1	0.33	1	2.02	0.70	1.13	3.85
Bidens pilosa	Tickseed	0.33	7.86	11.5	6.66	16.69	13.05	36.4
Baccharis halimifolia	Saltbush	0.48	1.62	4.6	9.70	3.44	5.22	18.36
Lepidium virginicum	Peppergrass	0.05	0.05	trace	1.01	0.11	--	1.12
Solidago microcephala	Goldenrod	0.1	0.19	1.0	2.02	0.40	1.13	3.55
Portulaca oleracea	Purslane	0.05	0.09	trace	1.01	0.19	--	1.2
Paspalum urvillei	Vasey grass	0.1	0.14	5.0	2.02	0.30	5.67	7.99
Setaria geniculata	Bristly foxtail	0.05	0.05	0.5	1.01	0.11	0.57	1.69
Crotalaria spectabilis	Rabbit bells	0.05	0.05	trace	1.01	0.11	--	1.12

Note: See footnotes at the end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 16 of 17)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 12[j] (continued)								
Stenotaphrum secundatum	St. Augustine grass	0.1	0.09	4.0	2.02	0.19	4.54	6.75
Pluchea purpurascens	Marsh fleabane	0.05	0.14	trace	1.01	0.30	--	1.31
Polypremum procumbens		0.05	0.14	trace	1.01	0.30	--	1.31
Solidago sempervirens var. mexicana	Goldenrod	0.05	0.09	2.0	1.0	0.19	2.27	3.47
Portulaca pilosa	Rose purslane	0.05	0.05	trace	1.01	0.11	--	1.12
Scoparia dulcis	Sweet broom	0.24	2.05	5.0	4.85	4.35	5.67	14.87
Schrankia microphylla	Sensitive brier	0.05	0.05	trace	1.01	0.11	--	1.12
Lythrum alatum var. lanceolatum	Loosestrife	0.1	0.29	1.0	2.02	0.66	1.13	3.81
Digitaria sanguinalis	Crabgrass	0.1	0.14	5.0	2.02	0.30	5.67	7.99
Myrica cerifera	Wax myrtle	0.05	0.05	0.5	1.01	0.11	0.57	1.69
Cyperus surinamensis	Sedge	0.14	0.33	trace	2.83	0.70	--	3.53

Note: See footnotes at the end of table.

Table 5-25. Vegetational analysis of Big Bend Station, Second Quarterly Report, 1974[a] (Sheet 17 of 17)

[a] From Long (1974b).

[b] Vegetation type: Ruderal.
Quadrat size: 1 m x 1 m.
Number analyzed: 22.

[c] Vegetation type: Ruderal.
Quadrat size: 1 m x 1 m.
Number analyzed: 19.

[d] Vegetation type: Marshy old field.
Quadrat size: 1 m x 1 m.
Number analyzed: 24.

[e] Vegetation type: Freshwater marsh (upper stratum).
Quadrat size: 5 m x 5 m.
Number analyzed: 7.

[f] Vegetation type: Herbaceous palmetto-*Juncus*.
Quadrat size: 1 m x 1 m.
Number analyzed: 30.

[g] Vegetation type: Herbaceous palmetto-pine.
Quadrat size: 1 m x 1 m.
Number analyzed: 32.

[h] Vegetation type: Pasture (lower stratum).
Quadrat size: 1 m x 1 m.
Number analyzed: 14.

[i] Vegetation type: Old field (upper stratum).
Quadrat size: 5 m x 5 m.
Number analyzed: 5.

[j] Vegetation type: Old field.
Quadrat size: 1 m x 1 m.
Number analyzed: 21.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 1 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 1[b]				
Sesbania exaltata	Sesban	0.38	0.92	2.2	4.56	3.67	5.02	13.25
Sporobolus domingensis	Dropseed	0.77	2.00	3.7	9.23	7.98	8.45	25.66
Chloris petraea	Finger grass	0.69	1.69	4.9	8.27	6.74	11.19	26.20
Vigna luteola	Cowpea	0.38	0.46	1.8	4.56	1.83	4.11	10.50
Digitaria adscendens	Crabgrass	0.15	2.38	6.0	1.80	9.50	13.70	25.00
Rhyncheletrum roseum	Red top	0.54	1.00	3.7	6.47	3.99	8.45	18.91
Typha sp.	Cattail	0.15	0.85	0.7	1.80	3.39	1.60	6.79
Solidago sempervirens var. *mexicana*	Goldenrod	0.69	3.69	8.1	8.27	14.72	18.49	41.48
Cyperus ligularis	Sedge	0.15	0.15	0.5	1.80	0.60	1.14	3.54
Andropogon glomeratus	Beard grass	0.46	1.23	1.2	5.51	4.90	2.74	13.15
Paspalum urvillei	Vasey grass	0.38	1.23	0.5	4.56	4.90	1.14	10.60
Leptochloa uninervia	Sprangletop	0.15	0.15	trace	1.80	0.60	--	2.40
Setaria geniculata	Bristly foxtail	0.23	0.23	trace	2.76	0.92	--	3.68
Eupatorium compositifolium	Dog fennel	0.69	3.46	3.2	8.27	13.81	7.31	29.39

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 2 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 1[b] (continued)					
Heterotheca subaxillaris	Camphor weed	0.15	0.15	trace	1.80	0.60	--	2.40
Echinochloa walteri		0.08	0.08	trace	0.96	0.32	--	1.28
Lythrum alatum var. *lanceolatum*	Loosestrife	0.08	0.08	trace	0.96	0.32	--	1.28
Pluchea purpurascens	Marsh fleabane	0.15	0.23	trace	1.80	0.92	--	2.72
Cyperus surinamensis	Sedge	0.08	0.08	trace	0.96	0.32	--	1.28
Cyperus polystachyos	Sedge	0.08	0.08	trace	0.96	0.32	--	1.28
Cenchrus echinata	Sandspur	0.08	0.08	trace	0.96	0.32	--	1.28
Baccharis halimifolia	Saltbush	0.38	2.07	4.6	4.56	8.26	10.50	23.32
Portulaca pilosa	Rose purslane	0.08	0.08	trace	0.96	0.32	--	1.28
Bidens pilosa	Tickseed	0.15	0.23	trace	1.80	0.92	--	2.72
Aster subulatus var. *ligulatus*		0.38	1.31	1.1	4.56	5.23	2.51	12.30
Ambrosia artemisiifolia	Ragweed	0.15	0.23	trace	1.80	0.92	--	2.72
Eleusine indica	Goosegrass	0.23	0.31	1.1	2.76	1.24	2.51	6.51

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 3 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 1[b] (continued)					
Melilotus alba	Sweet clover	0.15	0.23	trace	1.80	0.92	—	2.72
Lippia nodiflora	Frogbit	0.23	0.23	0.5	2.76	0.92	1.14	4.82
Eclipta alba		0.08	0.15	trace	0.96	0.60	—	1.56
			Study Site 4[c]					
Parthenocissus quinquefolia	Virginia creeper	0.44	0.78	1.8	4.54	2.55	4.13	11.22
Ampelopsis arborea	Pepper vine	0.22	0.33	1.2	2.27	1.08	2.75	6.10
Verbesina laciniata	Crownbeard	0.44	1.67	9.2	4.54	5.47	21.12	31.13
Rhyncheletrum roseum	Red top	0.55	1.33	0.5	5.68	4.36	1.15	11.19
Bidens pilosa	Tickseed	0.33	1.22	0.5	3.41	3.99	1.15	8.55
Ambrosia artemisiifolia	Ragweed	0.33	0.67	trace	3.41	2.19	—	5.60
Desmodium canum	Tick clover	0.33	0.67	trace	3.41	2.19	—	5.60
Desmodium triflorum	Tick clover	0.22	0.22	trace	2.27	0.72	—	2.99
Paspalum sp.		0.44	1.44	0.5	4.54	4.72	1.15	10.41
Vitus rotundifolia	Muscadine grape	0.33	0.44	0.8	3.41	1.44	1.84	6.69

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 4 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 4[c] (continued)								
Rubus trivialis	Blackberry	0.44	0.88	1.3	4.54	2.88	2.98	10.40
Setaria geniculata	Bristly foxtail	0.22	0.22	trace	2.27	0.72	—	2.99
Gaura angustifolia	Southern gaura	0.22	0.33	trace	2.27	1.08	—	3.35
Toxicodendron radicans sp. radicans	Poison ivy	0.11	0.11	trace	1.14	0.36	—	1.50
Paspalum urvillei	Vasey grass	0.33	0.55	3.4	3.41	1.80	7.81	13.02
Sida rhombifolia		0.44	0.77	0.8	4.54	2.52	1.84	8.90
Sporobolus domingensis	Dropseed	0.33	0.44	trace	3.41	1.44	—	4.85
Vitis aestivalis	Southern grape	0.22	0.33	0.5	2.27	1.08	1.15	4.50
Cyperus ligularis	Sedge	0.11	0.11	trace	1.14	0.36	—	1.50
Lippia nodiflora	Frogbit	0.33	0.55	1.1	3.41	1.80	2.52	7.73
Digitaria sanguinalis	Crabgrass	0.55	5.78	2.5	5.68	18.94	5.74	30.36
Solidago microcephala	Goldenrod	0.33	1.22	1.2	3.41	3.99	2.75	10.15
Passiflora suberosa	Passion vine	0.33	0.44	2.2	3.41	1.44	5.05	9.90
Chloris petraea	Finger grass	0.33	1.44	trace	3.41	4.72	—	8.13

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 5 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 4[c] (continued)				
Andropogon glomeratus	Beard grass	0.33	1.33	1.2	3.41	4.36	2.75	10.52
Typha sp.	Cattail	0.11	2.00	3.05	1.14	6.55	7.00	14.69
Tripsacum dactyloides	Gama grass	0.22	0.55	1.5	2.27	1.80	3.44	7.51
Crotolaria spectabilis	Rabbit bells	0.22	0.33	trace	2.27	1.08	—	3.35
Eleusine indica	Goosegrass	0.33	0.77	0.5	3.41	2.52	1.15	7.08
Eupatorium compositifolium	Dog fennel	0.33	1.69	2.3	3.41	5.54	5.28	14.23
				Study Site 5[d]				
Solidago sempervirens var. *mexicana*	Goldenrod	1.00	20.67	17.0	12.88	37.12	19.03	69.03
Solidago microcephala	Goldenrod	1.00	14.33	23.0	12.88	25.74	25.75	64.37
Juncus roemerianus	Black rush	0.58	3.75	15.2	7.47	6.73	17.02	31.22
Spartina bakeri	Cordgrass	0.67	1.42	5.2	8.63	2.55	5.82	17.00
Galactia elliottii	Milk pea	0.42	0.92	0.5	5.41	1.65	0.56	7.62
Pluchea rosea	Marsh fleabane	0.58	1.42	1.2	7.47	2.55	1.34	11.36

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 6 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 5[d] (continued)					
Scoparia dulcis	Sweet broom	0.67	3.92	5.5	8.63	7.04	6.16	21.83
Rubus trivialis	Blackberry	0.42	0.83	0.5	5.41	1.49	0.56	7.46
Hypericum cistifolium	St. John's wort	0.42	0.67	0.5	5.41	1.20	0.56	7.17
Andropogon glomeratus	Beard grass	0.42	1.25	1.5	5.41	2.24	1.68	9.33
Andropogon longiberbis	Beard grass	0.42	0.83	1.0	5.41	1.49	1.12	8.02
Tripsacum dactyloides	Eastern gama grass	0.25	1.67	7.5	3.22	2.99	8.40	14.61
Cladium jamaicense	Sawgrass	0.33	2.92	9.5	4.25	5.24	10.64	20.13
Verbesina laciniata	Crownbeard	0.33	0.67	1.2	4.25	1.20	1.34	6.79
Ludwigia octavalvis	False willow	0.25	0.41	trace	3.22	0.74	--	3.96
			Study Site 7[e]					
Borrichia frutescens	Sea daisies	0.25	61.83	7.5	6.51	12.47	6.22	25.20
Sesuvium portulacastrum	Sea purslane	0.67	4.92	5.5	17.45	0.99	4.56	23.00
Monanthocloe littoralis	Salt grass	0.75	107.58	26.2	19.53	21.70	21.74	62.97

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 7 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 7[e] (continued)				
Distichilis spicata	Salt grass	0.67	288.50	33.7	17.45	58.20	27.97	103.62
Batis maritima	Salt wort	0.33	1.75	6.0	8.59	0.35	4.98	13.92
Salicornia virginica	Glass wort	0.33	23.33	5.5	8.59	4.71	4.56	17.86
Juncus roemerianus	Black rush	0.25	5.17	6.1	6.51	1.04	5.06	12.61
Aster subulatus var. *ligulatus*		0.17	0.25	trace	4.43	0.05	--	4.48
Solidago sempervirens var. *mexicana*	Goldenrod	0.25	2.08	16.0	6.51	0.42	13.28	20.21
Spartina bakeri	Cordgrass	0.17	0.25	14.0	4.43	0.05	11.62	16.10
				Study Site 8[f]				
Solidago microcephala	Goldenrod	1.00	17.00	4.1	8.55	33.36	16.60	58.51
Solidago sempervirens var. *mexicana*	Goldenrod	0.87	4.25	3.2	7.43	8.34	12.95	28.72
Spartina bakeri	Cordgrass	0.37	0.75	5.1	3.16	1.47	20.65	25.28
Rhynchospora divergens	Sedge	0.50	1.12	0.2	4.27	2.20	0.81	7.28

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 8 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 8[f] (continued)					
Pluchea rosea	March fleabane	0.50	1.25	0.3	4.27	2.45	1.21	7.88
Lachnocaulon anceps	Bog button	0.50	1.00	trace	4.27	1.96	--	6.23
Hedyotis procumbens	Innocence	0.50	2.00	0.1	4.27	3.92	0.40	8.59
Panicum virgatus	Switch grass	0.37	1.12	0.5	3.16	2.20	2.02	7.38
Erianthus giganteus	Plumegrass	0.37	0.62	1.5	3.16	1.22	6.07	10.45
Galactia elliottii	Milk pea	0.50	2.00	1.2	4.27	3.92	4.86	13.05
Panicum breve	Panic grass	0.50	4.50	0.2	4.27	8.83	0.81	13.91
Samolus parviflorus	Pineland pimpernel	0.37	0.75	0.2	3.16	1.47	0.81	5.44
Juncus roemerianus	Black rush	0.25	2.25	1.1	2.14	4.41	4.45	11.00
Fimbristylis castanea	Fringe rush	0.37	0.75	0.5	3.16	1.47	2.02	6.65
Oxalis dillenii	Yellow sorrel	0.37	0.50	trace	3.16	0.98	--	4.14
Scoparia dulcis	Sweet broom	0.75	3.25	2.0	6.41	6.38	8.10	20.89
Andropogon virginicus	Broom sedge	0.50	1.00	0.5	4.27	1.95	2.02	8.25
Andropogon longiberbis	Beard grass	0.25	0.37	trace	2.13	0.73	--	2.86

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 9 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 8[f] (continued)					
Hypericum cistifolium	St. John's wort	0.50	1.50	0.5	4.27	2.94	2.02	9.23
Vitis rotundifolia	Muscadine grape	0.25	0.25	0.5	2.14	0.49	2.02	4.65
Ludwigia octavalvis	Water purslane	0.37	0.87	0.2	3.16	1.71	0.81	5.68
Amorpha herbacea	Lead plant	0.50	0.87	0.6	4.27	1.71	2.43	8.41
Gaura angustifolia	Southern gaura	0.25	0.50	trace	2.14	0.98	—	3.12
Verbesina laciniata	Crownbeard	0.37	1.12	1.0	3.16	2.20	4.05	9.41
Andropogon glomeratus	Beard grass	0.37	1.00	1.2	3.16	1.96	4.86	9.98
Lobelia feayana	Bay lobelia	0.25	0.37	trace	2.14	0.73	—	2.87
			Study Site 9[g]					
Hydrocotyle umbellata	Water pennywort	0.80	1.73	9.6	9.29	9.07	9.84	28.20
Digitaria adscendens	Crabgrass	0.80	2.73	29.2	9.29	12.31	29.92	53.52
Desmodium canum	Tick clover	0.67	1.20	10.1	7.78	6.29	10.35	24.42
Dichromena colorata	White top	0.47	1.60	2.3	5.46	8.38	2.36	16.20
Bacopa cyclophylla		0.40	0.67	2.3	4.64	3.51	2.36	10.51

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 10 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 9[g] (continued)					
Setaria geniculata	Bristly foxtail	0.33	0.40	1.0	3.83	2.10	1.02	6.95
Lippia nodiflora	Frogbit	0.40	0.67	4.3	4.64	3.51	4.40	12.55
Andropogon glomeratus	Beard grass	0.47	0.87	7.3	5.46	4.56	7.48	17.50
Centella asiatica	Coin wort	0.87	1.27	11.9	10.10	6.66	12.19	28.95
Solidago sempervirens var. mexicana	Goldenrod	0.40	0.53	0.5	4.64	2.78	0.51	7.93
Fimbristylis castanea	Fringe rush	0.40	0.47	3.2	4.64	2.46	3.28	10.38
Cyperus surinamensis	Sedge	0.47	1.27	1.05	5.46	6.66	1.07	13.19
Eupatorium compositifolium	Dog fennel	0.53	1.60	7.2	6.15	8.38	7.38	21.91
Rubus trivialis	Blackberry	0.27	0.33	2.3	3.13	1.73	2.36	7.22
Sida acuta		0.20	0.27	trace	2.32	1.4	—	3.46
Solidago microcephala	Goldenrod	0.27	0.80	1.35	3.13	4.19	1.38	8.70
Paspalum urvillei	Vasey grass	0.20	0.27	1.3	2.32	1.42	1.33	5.07
Aster subulatus var. liqulatus		0.33	1.47	2.2	3.83	7.70	2.25	13.78

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 11 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 9[g] (continued)					
Pluchea rosea	Marsh fleabane	0.20	0.33	trace	2.32	1.73	--	4.05
Eleusine indica	Goosegrass	0.13	0.60	0.5	1.51	3.14	0.51	5.16
			Study Site 11[h]					
Solidago microcephala	Goldenrod	0.80	7.30	57.2	17.78	58.40	69.46	145.64
Crotolaria spectabilis	Rabbit bells	0.40	0.50	1.3	8.89	4.00	1.58	14.47
Crotolaria mucronata	Rabbit bells	0.20	0.30	0.75	4.44	2.40	0.91	7.75
Parthenocissus quinquefolia	Virginia creeper	0.10	0.10	1.0	2.22	0.80	1.21	4.23
Solidago sempervirens var. mexicana	Goldenrod	0.30	0.50	0.5	6.67	4.00	0.61	11.28
Lippia nodiflora	Frogbit	0.30	0.40	0.6	6.67	3.20	0.73	10.60
Rubus trivialis	Blackberry	0.60	0.70	17.0	13.33	5.60	20.64	39.57
Eupatorium compositifolium	Dog fennel	0.50	0.90	1.5	11.11	7.20	1.82	20.13
Melothria pendula var. pendula	Trailing cucumber	0.10	0.10	trace	2.22	0.80	--	3.02

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 12 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 11[h] (continued)				
Ambrosia artemisiifolia	Ragweed	0.20	0.30	trace	4.44	2.40	—	6.84
Chenopodium ambrosioidas	Goosefoot	0.20	0.20	trace	4.44	1.60	—	6.04
Phytolacca americana	Pokeweed	0.20	0.20	0.5	4.44	1.60	0.61	6.65
Callicarpa americana	Beauty berry	0.10	0.20	1.0	2.22	1.60	1.21	5.03
Portulaca pilosa	Rose purslane	0.10	0.10	trace	2.22	0.80	—	3.02
Physalis angustifolia	Ground cherry	0.20	0.30	0.5	4.44	2.40	0.61	7.45
Tillandsia recurvata	Air plant	0.10	0.20	trace	2.22	1.60	—	3.82
Vitis rotundifolia	Muscadine grape	0.10	0.20	0.5	2.22	1.60	0.61	4.43
				Study Site 12[i]				
Eupatorium compositifolium	Dog fennel	0.96	12.10	21.48	12.03	31.97	27.84	71.84
Lippia nodiflora	Frogbit	0.30	0.61	7.5	3.76	1.61	9.72	15.09
Ambrosia artemisiifolia	Ragweed	0.48	1.96	2.45	6.02	5.18	3.17	14.37
Conyza canadensis	Dwarf horseweed	0.48	1.35	1.77	6.02	3.57	2.29	11.88

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 13 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 12[i] (continued)					
Ludwigia octavalvis	Water purslane	0.22	0.30	0.60	2.76	0.79	0.78	4.33
Cyperus surinamensis	Sedge	0.87	1.87	1.32	10.90	4.94	1.71	17.55
Bidens pilosa	Tickseed	0.48	2.00	1.60	6.02	5.28	2.07	13.37
Baccharis halimifolia	Saltbush	0.48	0.83	7.73	6.02	2.19	10.02	18.23
Setaria geniculata	Bristly foxtail	0.04	0.04	3.67	0.50	0.10	4.76	5.36
Crotolaria spectabilis	Rabbit bells	0.04	0.04	trace	0.50	0.10	--	0.6
Pluchea purpurascens	Marsh fleabane	0.04	0.0	0.65	0.50	0.10	0.84	1.44
Solidago sempervirens var. *mexicana*	Goldenrod	0.43	1.00	1.1	5.39	2.64	1.42	9.45
Scoparia dulcis	Sweet broom	0.26	0.35	trace	3.26	0.92	--	4.18
Digitaria sanguinalis	Crabgrass	0.52	4.35	6.01	6.52	11.49	7.79	25.80
Indigofera hirsuta	Indigo bush	0.78	7.87	15.68	9.77	20.79	20.32	50.88
Eleusine indica	Goosegrass	0.22	0.35	trace	2.76	0.92	--	3.68
Eclipta alba		0.17	0.26	trace	2.13	0.69	--	2.82

Note: See footnotes at end of table.

Table 5-26. Vegetational analysis of Big Bend Station, Third Quarterly Report, 1974[a] (Sheet 14 of 14)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 12[i] (continued)					
Aster subulatus var. *ligulatus*		0.30	0.35	1.20	3.76	0.92	1.55	6.23
Chamaesyce hyssopifolia	Spurge	0.56	1.83	2.75	7.02	4.8	3.56	15.38
Andropogon glomeratus	Beard grass	0.17	0.17	trace	2.13	0.45	—	2.58
Heterotheca subaxillaris	Camphor weed	0.09	0.09	1.00	1.13	0.24	1.30	2.67
Schinus terebinthefolius	Brazilian pepper	0.09	0.09	0.65	1.13	0.24	0.84	2.21

[a] From Wunderlin and Long (1975a).

[b] Vegetation type: Ruderal.
Quadrat size: 1 m x 1 m.
Number analyzed: 22.

[c] Vegetation type: Freshwater marsh (lower stratum).
Quadrat size: 1 m x 1 m.
Number analyzed: 9.

[d] Vegetation type: Herbaceous. Palmetto-*Juncus*
Quadrat size: 1 m x 1 m.
Number analyzed: 12.

[e] Vegetation type: Salt prairie.
Quadrat size: 1 m x 1 m.
Number analyzed: 12.

[f] Vegetation type: Herbaceous. Palmetto-pine.
Quadrat size: 1 m x 1 m.
Number analyzed: 24.

[g] Vegetation type: Pasture (lower stratum).
Quadrat size: 1 m x 1 m.
Number analyzed: 14.

[h] Vegetation type: Old field.
Quadrat size: 1 m x 1 m.
Number analyzed: 10.

[i] Vegetational type: Old field.
Quadrat size: 1 m x 1 m.
Number analyzed: 23.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 1 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 1[b]				
Melilotus alba	Sweet clover	0.7	7.7	13.5	12.1	43.5	35.9	91.5
Chloris petraea	Finger grass	0.7	2.0	6.2	12.1	11.3	16.5	39.9
Rhynchelytrum repens	Natal grass	0.5	0.9	3.4	8.6	5.1	9.0	22.7
Vigna luteola	Cowpea	0.8	0.8	2.9	13.8	4.5	7.7	26.0
Heterotheca subaxillaris	Camphor weed	0.3	0.3	trace	5.2	1.7	--	6.9
Solidago sempervirens	Goldenrod	0.3	0.7	2.1	5.2	3.9	5.6	14.7
Sporobolus domingensis	Dropseed	0.6	1.4	3.5	10.3	7.9	9.3	27.5
Baccharis halimifolia	Saltbush	0.4	1.5	4.2	6.9	8.5	11.2	26.6
Eupatorium compositifolium	Dog fennel	0.3	0.5	0.5	5.2	2.8	1.3	9.3
Andropogon glomeratus	Beard grass	0.4	0.9	0.5	6.9	5.1	1.3	13.3
Lippia nodiflora	Frogbit	0.3	0.4	trace	5.2	2.2	--	7.4
Bidens pilosa	Tickseed	0.3	0.3	trace	5.2	1.7	--	6.9
Eleusine indica	Goosegrass	0.2	0.3	0.8	3.4	1.7	2.1	7.2
				Study Site 4[b]				
Bidens pilosa	Tickseed	0.7	3.7	3.2	9.3	14.2	5.5	29.0
Vitus aestivalis	Grape	0.3	0.4	1.6	4.0	1.5	2.7	8.2
Ampelopsis arborea	Pepper vine	0.4	0.6	1.7	5.3	2.3	2.9	10.5
Panicum purpureum	Panic grass	0.3	2.5	6.9	4.0	9.6	11.8	25.4

Note: See footnotes at end of table.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 2 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 4[b] (continued)				
Verbesina lacinata	Crownbeard	0.6	2.1	12.3	8.0	8.0	21.1	37.1
Vitus rotundifolia	Grape	0.4	0.5	3.4	5.3	1.9	5.8	13.0
Tripsacum dactyloides	Gama grass	0.3	0.5	1.0	4.0	1.9	1.7	7.6
Sida acuta		0.4	0.7	3.5	5.3	2.7	6.0	14.0
Vigna luteola	Cowpea	0.3	0.3	4.7	4.0	1.1	8.1	13.2
Sporobolus domingensis	Dropseed	0.2	0.3	trace	2.7	1.1	—	3.8
Parthenocissus quinquefolia	Virginia creeper	0.3	0.4	1.2	4.0	1.5	2.1	7.6
Ambrosia artemisiifolia	Ragweed	0.4	5.8	7.0	5.3	22.2	12.0	39.5
Passiflora suberosa	Passion flower	0.3	0.5	2.8	4.0	1.9	4.8	10.7
Desmodium canum	Tick clover	0.3	0.6	trace	4.0	2.3	—	6.3
Rubus trivialis	Blackberry	0.4	0.8	2.1	5.3	3.1	3.6	12.0
Chenopodium ambrosioides	Goosefoot	0.3	0.4	0.9	4.0	1.5	1.5	7.0
Linaria canadensis	Toadflax	0.2	1.3	trace	2.7	4.9	—	7.6
Geranium carolinianum	Cranesbill	0.3	1.1	trace	4.0	4.2	—	8.2
Ludwigia peruviana	Primrose	0.2	0.3	1.0	2.7	1.1	1.7	5.5
Medicago lupulina	Black medic	0.1	0.2	trace	1.3	0.8	—	2.1
Andropogon glomeratus	Beard grass	0.3	0.7	0.5	4.0	2.7	0.8	7.5

Note: See footnotes at end of table.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 3 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 4[b] (continued)					
Gaura angustifolia	Southern gaura	0.2	0.5	trace	2.7	1.9	—	4.6
Eleusine indica	Goosegrass	0.2	0.3	trace	2.7	1.1	—	3.8
Typha latifolia	Cattail	0.1	1.6	4.5	1.3	6.1	7.7	15.1
			Study Site 5[c]					
Solidago microcephala	Goldenrod	0.8	8.7	21.5	12.5	22.5	27.6	62.6
Scoparia dulcis	Sweet broom	0.6	2.5	8.0	9.4	6.5	10.2	26.1
Rubus trivialis	Blackberry	0.5	0.8	2.2	7.8	2.1	2.8	12.7
Solidago sempervirens	Goldenrod	0.7	13.3	12.2	10.9	34.4	15.6	60.9
Cladium jamaicense	Saw grass	0.4	2.8	8.1	6.2	7.2	10.4	23.8
Andropogon glomeratus	Beard grass	0.3	0.6	trace	4.7	1.5	—	6.2
Galactia elliottii	Milk pea	0.5	1.1	0.9	7.8	2.8	1.2	11.8
Juncus roemarianus	Black rush	0.6	5.4	14.5	9.4	13.9	18.6	41.9
Chloris petraea	Finger grass	0.2	0.2	trace	3.1	0.5	—	3.6
Smilax laurifolia	Cat briar	0.2	0.2	trace	3.1	0.5	—	3.6
Physalis angustifolia	Ground cherry	0.3	0.5	0.5	4.7	1.3	0.6	6.6
Spartina bakeri	Cordgrass	0.4	0.6	4.3	6.2	1.5	5.5	13.2
Tripsacum dactyloides	Gama grass	0.2	0.8	4.2	3.1	2.1	5.4	10.6

Note: See footnotes at end of table.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 4 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 5[c] (continued)				
Pluchea purpurascens		0.3	0.4	trace	4.7	1.0	--	5.7
Verbesina laciniata	Crownbeard	0.4	0.7	1.5	6.2	1.8	1.9	9.9
				Study Site 7[d]				
Borrichia frutescens	Sea daisies	0.3	65.4	6.3	9.1	16.3	7.4	32.8
Monanthochloe littoralis	Salt grass	0.6	125.6	24.5	18.2	31.3	28.7	78.2
Batis maritima	Saltwort	0.3	1.1	6.8	9.1	0.3	7.9	17.3
Sesuvium portulacastrum	Sea purslane	0.5	2.7	5.1	15.1	0.7	5.9	21.7
Distichilis spicata	Salt grass	0.5	192.4	30.5	15.1	47.9	35.8	98.8
Spartina spartinae	Cordgrass	0.1	0.2	trace	3.0	0.05	—	3.05
Juncus roemarianus	Black rush	0.2	4.1	5.5	6.1	1.0	6.4	13.5
Aster tenuifolius		0.2	0.2	trace	6.1	0.05	—	6.15
Agalinis maritima		0.2	0.2	trace	6.1	0.05	—	6.15
Salicornia virginica		0.2	8.5	4.6	6.1	2.1	5.4	13.6
Spartina bakeri	Cordgrass	0.2	0.8	2.0	6.1	0.2	2.3	8.6
Spartina bakeri	Cordgrass	0.3	0.6	4.4	3.4	1.5	16.0	20.9

Note: See footnotes at end of table.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 5 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 8[e]				
Solidago microcephala	Goldenrod	0.9	13.7	3.6	10.3	35.3	13.1	58.7
Solidago sempervirens	Goldenrod	0.7	2.0	2.1	8.0	5.1	7.7	20.8
Pluchea rosea	Fleabane	0.3	0.7	trace	3.4	1.8	--	5.2
Panicum virgatum	Panic grass	0.2	0.3	trace	2.3	0.8	--	3.1
Samolus parviflora	Pimpernel	0.2	0.4	trace	2.3	1.0	--	3.3
Lobelia feyana	Bay lobelia	0.4	3.7	0.5	4.6	9.5	1.8	15.9
Galactica elliottii	Milk pea	0.7	3.0	2.5	8.0	7.7	9.1	24.8
Hypericum cistifolium	St. John's wort	0.3	0.7	0.5	3.4	1.8	1.8	7.0
Rhynchospora divergens		0.3	0.9	trace	3.4	2.3	--	5.7
Juncus roemarianus	Black rush	0.3	2.5	1.5	3.4	6.4	5.5	15.3
Andropogon virginianus	Beard grass	0.4	1.2	trace	4.6	3.1	--	7.7
Ludwigia octavalvis		0.1	0.1	trace	1.1	0.3	--	1.4
Verbesina laciniata	Crownbeard	0.6	1.9	2.2	6.8	5.0	8.0	19.8
Hedyotis procumbens	Innocence	0.2	0.4	trace	2.3	1.0	--	3.3
Andropogon glomeratus	Beard grass	0.2	0.5	trace	2.3	1.3	--	3.6
Scoparia dulcis	Sweet broom	0.7	2.7	5.2	8.0	6.9	19.0	33.9
Fimbristylis castanea	Fringerush	0.2	0.4	0.5	2.3	1.0	1.8	5.1

Note: See footnotes at end of table.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 6 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 8[e] (continued)					
Vitis rotundifolia	Grape	0.3	0.5	1.0	3.4	1.3	3.6	8.3
Amorpha herbacea	Lead plant	0.6	1.3	1.5	6.8	3.3	5.5	15.6
Gaura angustifolia	Southern gaura	0.2	0.3	trace	2.3	0.8	—	3.1
Smilax laurifolia	Catbrier	0.2	0.2	0.5	2.3	0.5	1.8	4.6
Rubus trivialis		0.4	0.8	1.4	4.6	2.1	5.1	11.8
			Study Site 11[f]					
Rubus trivialis	Blackberry	0.7	1.6	26.5	14.6	10.8	33.8	59.2
Solidago microcephala	Goldenrod	0.7	6.5	48.2	14.6	43.9	61.5	120.0
Lippia nodiflora	Frogbit	0.4	0.5	1.0	8.3	3.4	1.3	13.0
Eupatorium compositifolium	Dog fennel	0.4	1.6	1.0	8.3	10.8	1.3	20.4
Ambrosia artemisiifolia	Ragweed	0.4	0.9	trace	8.3	6.1	—	14.4
Phytolacca americana	Poke weed	0.3	0.4	15	6.2	2.7	0.6	9.5
Crotalaria spectabilis	Rabbit bells	0.3	0.3	trace	6.2	2.0	—	8.2
Solidago sempervirens	Goldenrod	0.4	0.7	trace	8.3	4.7	—	13.0
Chenopodium ambrosioides	Goosefoot	0.3	0.4	trace	6.2	2.7	—	8.9
Physalis angustifolia	Ground cherry	0.4	1.0	0.6	8.3	6.7	0.8	15.8

Note: See footnotes at end of table.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 7 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 11[f] (continued)					
Vitis rotundifolia	Grape	0.1	0.3	0.5	2.1	2.0	0.6	4.7
Callicarpa americana	Beauty berry	0.1	0.1	trace	2.1	0.7	—	2.8
Tillandsia recurvata	Air plant or ball moss	0.3	0.5	trace	6.2	3.4	—	9.6
			Study Site 12[g]					
Lippia nodiflora	Frogbit	0.6	0.9	10.2	7.2	2.9	24.6	34.7
Eupatorium compositifolium	Dog fennel	0.9	6.5	12.4	10.8	21.0	29.9	61.7
Conyza canadensis	Horseweed	0.7	4.4	2.5	8.4	14.2	6.0	28.6
Ambrosia artemisiifolia	Ragweed	0.7	7.0	4.8	8.4	22.6	11.6	42.6
Oenothera laciniata		0.6	1.0	1.5	7.2	3.2	3.6	14.0
Lepidium virginicum	Poor man's pepper	0.6	1.9	1.0	7.2	6.1	2.4	15.7
Cyperus surinamensis	Sedge	0.4	0.5	trace	4.8	1.6	—	6.4
Baccharis halimifolia	Salt bush	0.5	0.9	7.5	6.0	2.9	18.1	27.0
Sonchus asper	Sow thistle	0.4	0.4	trace	4.8	1.3	—	6.1
Stenotaphrum secondatum	St. Augustine grass	0.4	2.4	0.5	4.8	7.8	1.2	13.8
Solidago sempervirens	Goldenrod	0.4	1.0	trace	4.8	3.2	—	8.0

Note: See footnotes at end of table.

Table 5-27. Vegetational analysis of Big Bend Station, Fourth Quarterly Report, 1975[a] (Sheet 8 of 8)

Scientific name	Common name	Frequency	Density (No./m^2)	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 12[g] (continued)					
Paspalum urvillei	Vasey grass	0.3	0.3	0.5	3.6	1.0	1.2	5.8
Linaria canadensis	Toad flax	0.5	2.0	trace	6.0	6.5	—	12.5
Andropogon glomeratus	Beard grass	0.3	0.4	trace	3.6	1.3	—	4.9
Heterotheca subaxillaris	Camphor weed	0.3	0.3	trace	3.6	1.0	—	4.6
Scoparia dulcis	Sweet broom	0.4	0.7	0.5	4.8	2.3	1.2	8.3
Eleusine indica	Goosegrass	0.3	0.3	trace	3.6	1.0	--	4.6

[a] From Wunderlin and Long (1975a).

[b] Vegetation type: Ruderal.
Quadrat size: 1 x 1.

[c] Vegetation type: Mixed palmetto-salt prairie.
Quadrat size: 1 x 1.

[d] Vegetation type: Herbaceous.
Quadrat size: 1 x 1.

[e] Vegetation type: Pine-palmetto scrub.
Quadrat size: 1 x 1.

[f] Vegetation type: Old field.
Quadrat size: 1 x 1.

[g] Vegetation type: Abandoned farmland.
Quadrat site: 1 x 1.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 1 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 1[b]					
Chloris petraea	Finger grass	0.72	1.63	7.0	11.6	8.67	21.1	41.3
Melilotus alba	Sweet clover	0.63	5.72	12.7	10.2	30.4	38.25	48.0
Chamaesyce sp.	Spurge	0.18	0.27	trace	2.9	1.43	—	4.3
Rhynchelytrum repens	Natal grass	0.63	1.54	4.1	10.2	8.2	12.3	30.7
Vigna luteola	Cowpea	0.54	0.72	2.5	8.7	3.8	7.5	20.0
Heterotheca subaxillaris	Camphor weed	0.36	0.19	0.5	5.8	10.1	1.5	17.4
Cenchrus sp.	Sand spur	0.27	0.27	trace	4.4	1.4	—	5.8
Eupatorium compositifolium	Dog fennel	0.54	1.72	1.5	8.7	9.1	4.5	22.3
Solidago sempervirens	Goldenrod	0.27	1.09	1.0	4.4	5.8	3.0	13.2
Conyza canadensis	Horseweed	0.36	1.0	0.5	5.8	5.3	1.5	12.6
Chenopodium ambrosioides	Goosefoot	0.27	0.36	0.7	4.4	1.9	2.1	8.4
Eleusine indica	Goose grass	0.27	0.36	1.7	4.4	1.9	5.1	11.4
Bidens pilosa	Tickseed	0.36	0.54	0.5	5.8	2.9	1.5	10.2
Lippia nodiflora	Frogbit	0.18	0.18	0.5	2.9	1.0	1.5	5.3
Solidago microcephala	Goldenrod	0.27	0.81	trace	4.4	4.3	—	8.7
Portulaca pilosa	Purslane	0.18	0.27	trace	2.9	1.43	—	4.3
Ambrosia artemisiifolia	Ragweed	0.18	0.45	trace	2.9	2.4	—	5.3

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975^a (Sheet 2 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 2^b								
Lippia nodiflora	Frogbit	0.33	0.44	2.5	4.7	0.51	1.7	6.8
Ipomea trichocarpa	Morning glory	0.55	4.8	3.2	7.9	5.6	2.2	15.7
Bidens pilosa	Tickseed	0.66	13.5	25.5	9.4	15.8	17.7	42.9
Paspalum notatum		0.33	1.1	0.5	4.7	1.3	0.35	6.2
Eupatorium compositifolium	Dog fennel	0.55	3.7	7.8	7.9	4.4	5.4	17.6
Cynodon dactylon		0.77	28.1	72.5	11.0	33.0	50.3	94.3
Ambrosia artemisiifolia	Ragweed	0.55	20.3	27.2	7.9	23.8	18.9	50.6
Aeschynomene americana	Sensitive jointvetch	0.33	0.77	1.0	0.47	0.9	0.7	6.3
Sonchus asper	Sow thistle	0.22	0.22	trace	3.1	0.25	--	3.4
Sambucus simpsonii	Southern elderberry	0.22	0.33	0.5	3.1	0.39	0.35	3.8
Chenopodium ambrosioides	Goosefoot	0.44	3.0	1.0	6.3	3.5	0.7	10.5
Lythrum sp.	Loosestrife	0.11	0.22	trace	1.6	0.25	--	1.85
Lepidium virginicum	Peppergrass	0.55	1.0	0.5	7.9	1.2	0.35	9.4
Cyperus surinamensis	Sedge	0.22	1.0	0.5	3.1	1.2	0.35	4.7
Desmodium canum	Tick clover	0.22	1.2	trace	3.1	1.4	--	4.5
Conyza canadensis	Horseweed	0.44	0.39	0.8	6.3	4.6	0.55	11.4
Ludwigia octovalvis	Primrose	0.33	1.0	0.5	4.7	1.2	0.35	6.2
Urena lobata	Caesar weed	0.22	0.44	0.5	3.1	0.51	.35	3.9

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 3 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 4[b]					
Amaranthus hybridus	Pigweed	0.40	1.80	2.8	4.9	5.3	4.9	15.1
Ambrosia artemisiifolia	Ragweed	0.40	4.40	6.2	4.9	13.0	10.8	28.7
Stenotaphrum secundatum	St. Augustine grass	0.20	1.0	0.5	2.5	2.9	0.9	6.3
Paspalum urvillei	Vasey grass	0.20	0.20	trace	2.5	0.6	—	3.1
Lippia nodiflora	Frogbit	0.30	0.60	0.5	3.7	1.7	0.9	6.3
Gaura angustifolia	Southern gaura	0.30	0.60	trace	3.7	1.8	—	5.5
Bidens pilosa	Tickseed	0.70	10.10	17.1	8.6	29.9	29.8	68.3
Sida acuta	Sida	0.40	1.20	4.0	4.9	3.5	6.9	15.3
Desmodium canum	Tick clover	0.30	0.50	trace	3.7	1.5	—	5.2
Verbesina laciniata	Crownbeard	0.40	1.60	10.2	4.9	4.7	17.8	27.4
Polygala grandiflora	Candyroot	0.20	0.30	trace	2.5	0.9	—	3.4
Paspalum notatum		0.40	1.10	0.5	4.9	3.2	0.9	9.0
Cenchrus sp.	Sandspur	0.10	0.10	trace	1.2	0.3	—	1.5
Ampelopsis arborea	Pepper vine	0.30	0.40	2.0	3.7	1.2	3.5	8.4
Panicum purpureum	Panic grass	0.20	2.20	5.2	2.5	6.5	9.1	18.1
Vistis rotundifolia	Wild grape	0.30	0.50	0.7	3.7	1.5	1.2	6.4
Passiflora suberosa	Passion flower	0.30	0.50	2.5	3.7	1.5	4.4	9.6
Desmodium tortuosum		0.20	0.30	trace	2.5	0.9	—	3.4

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 4 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 4[b] (continued)								
Tripsacum dactyloides	Gama grass	0.10	0.80	1.2	1.2	2.4	2.1	5.7
Parthenocissus quinquefolia	Virginia creeper	0.30	0.40	1.0	3.7	1.2	1.7	6.6
Lepidium virginicum	Peppergrass	0.30	1.00	0.5	3.7	2.9	0.9	7.5
Vitis aestivalis	Grape	0.30	0.40	1.4	0.37	1.2	2.4	7.3
Rhynchetytrum repens	Red tops	0.20	0.70	trace	2.5	2.1	--	4.6
Sporobolus domingensis	Dropseed	0.20	0.40	0.5	2.5	1.2	--	3.7
Crotalaria spectabilis	Rattle boxes	0.20	0.50	0.6	2.5	1.5	1.3	5.3
Chenopodium ambrosioides	Goosefoot	0.30	0.70	1.0	3.7	2.1	1.7	7.3
Conyza canadensis	Horseweed	0.10	0.10	trace	1.2	0.3	--	1.4
Aeschynomene americana	Sensitive jointvetch	0.30	0.80	trace	3.7	2.4	--	6.0
Cyperus surinamensis	Sedge	0.20	0.60	trace	2.5	1.8	--	4.3
Study Site 7[c]								
Chloris petraea	Finger grass	0.22	0.67	trace	5.1	0.2	--	5.3
Monanthochloe littoralis	Salt grass	0.55	152.22	22.8	12.8	43.5	29.2	85.5
Distichilus spicata	Salt grass	0.55	176.78	27.5	12.8	50.5	35.2	98.5

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 5 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 7[c] (continued)					
Sesuvium portulacastrum	Sea purslane	0.55	3.11	4.6	12.8	0.9	5.9	19.6
Borrichia frutescens	Sea daisies	0.22	15.5	5.5	5.1	0.1	7.0	12.2
Agalinus maritima		0.22	0.44	trace	5.1	0.1	--	5.2
Spartina spartinae	Cordgrass	0.22	0.33	0.5	5.1	0.1	0.6	5.8
Philoxerus vermicularis	Saltweed	0.33	0.33	0.8	7.7	0.1	1.0	8.8
Spartina bakeri	Cordgrass	0.22	0.55	4.2	5.1	0.2	5.4	10.7
Salicornia virginica	Glasswort	0.33	8.89	5.1	7.7	2.5	6.5	16.7
Batis maritima	Saltwort	0.33	1.11	5.0	7.7	0.3	6.4	14.4
Juncus roemarianus	Black rush	0.22	4.44	1.5	5.1	1.3	1.9	8.3
Vigna luteola	Cowpea	0.11	0.11	trace	2.6	0.03	--	2.63
Fimbristylis castanea		0.22	0.55	0.5	5.1	0.2	0.6	5.9
			Study Site 8[d]					
Solidago sempervirens	Goldenrod	0.63	3.8	2.5	6.33	7.2	9.0	22.5
Solidago microcephala	Goldenrod	0.63	18.9	4.8	6.3	36.0	17.3	59.6
Pluchea rosea	Marsh fleabane	0.38	1.1	0.5	3.8	2.0	1.8	7.6
Hypericum cistifolium	St. John's wort	0.25	0.25	trace	2.5	0.5	--	3.0

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 6 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 8[d] (continued)								
Galactia elliottii	Milk pea	0.63	3.0	2.0	6.3	5.7	7.2	19.2
Erianthus giganteus	Plume grass	0.25	0.25	0.5	2.5	0.5	1.8	4.8
Gnaphalium purpureum		0.38	0.87	trace	3.8	1.6	--	5.4
Lobelia feayana	Bay lobelia	0.50	1.3	0.5	5.0	2.5	1.8	9.3
Panicum virgatum	Switch grass	0.25	0.75	trace	2.5	1.4	--	3.9
Rhynchospora divergens		0.38	1.3	trace	3.8	2.5	--	6.3
Spartina bakeri	Cordgrass	0.38	1.1	4.7	3.8	2.0	1.0	--
Scutellaria integrifolia	Skull cap	0.5	4.0	0.5	5.0	7.6	1.0	--
Oxalis dillenii	Oxalis	0.25	0.5	trace	2.5	0.9	--	3.4
Verbesina laciniata	Crownbeard	0.38	0.87	0.5	3.8	1.6	1.8	7.2
Samolus parviflorus	Pineland pimpernel	0.25	0.63	trace	2.5	1.2	--	3.7
Samolus ebracteatus	Pimpernel	0.13	0.13	trace	1.3	0.24	--	1.5
Solidago chapmannii	Goldenrod	0.38	3.10	1.5	3.8	5.9	5.4	15.1
Scoparia dulcis	Sweet broom	0.75	3.50	4.8	7.5	6.6	17.3	31.4
Hedyotis procumbens	Innocence	0.63	2.50	trace	6.3	4.7	--	11.0
Vitis rotundifolia	Wild grape	0.25	0.38	1.2	2.5	0.7	4.3	7.5
Guara angustifolia	Southern gaura	0.25	0.38	trace	2.5	0.7	--	3.2
Amorpha herbacea	Lead plant	0.63	2.1	2.2	6.3	4.0	7.9	18.2

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 7 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
				Study Site 8[d] (continued)				
Rubus trivialis	Dewberry	0.13	0.25	0.5	1.3	0.5	1.8	3.6
Lachnocaulon anceps	Button bags	0.25	0.63	trace	2.51	1.2	--	3.7
Smilax auriculata	Catbrier	0.25	0.25	0.5	2.5	0.5	1.8	4.8
Fimbristylis castanea		0.25	0.63	0.5	2.5	1.2	1.8	5.5
				Study Site 9[e]				
Setaria geniculata	Foxtails	0.6	1.1	2.1	7.5	5.8	2.2	15.5
Dichromena colorata	White tops	0.6	1.2	1.8	7.5	6.3	1.9	15.7
Digitaria adscendens	Crabgrass	0.9	3.6	34.5	11.2	19.0	36.2	66.4
Fimbristylis castanea	Sedge	0.6	0.8	2.7	7.5	4.2	2.8	14.5
Lippia nodiflora	Frogbit	0.6	0.7	3.8	7.5	3.7	3.9	15.1
Desmodium canum	Tick clover	0.8	1.4	8.5	10.0	7.4	8.9	26.3
Hydrocotyle umbellata	Pennywort	0.4	1.2	6.7	5.0	6.3	7.0	18.3
Paspalum notatum		0.8	3.8	26.0	10.0	20.1	27.4	57.4
Rubus trivialis	Southern dewberry	0.3	0.5	2.5	3.7	2.6	2.6	8.9
Phytolacca americana	Pokeweed	0.2	0.2	1.4	2.5	1.0	1.5	5.0
Cyperus surinamensis	Sedge	0.5	0.8	0.7	6.2	4.2	0.7	11.1
Eleusine indica	Goose grass	0.5	1.0	1.5	6.2	5.3	1.6	13.1

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 8 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 9[e] (continued)					
Pluchea rosea	Marsh fleabane	0.3	0.5	0.5	3.7	2.6	0.5	6.8
Solidago microcephala	Goldenrod	0.5	1.2	2.0	6.2	6.3	2.1	14.6
Solidago sempervirens	Goldenrod	0.2	0.3	trace	2.5	1.6	—	4.1
Eupatroium compositifolium	Dog fennel	0.2	0.6	0.5	2.5	3.2	0.5	6.2
			Study Site 11[f]					
Rubus trivialis	Southern dewberry	0.75	2.5	32.5	13.7	10.7	37.7	62.1
Solidago sempervirens	Goldenrod	1.50	1.25	1.5	9.1	5.3	1.7	16.1
Solidago microcephala	Goldenrod	1.75	13.0	46.0	13.7	55.7	53.4	122.8
Lantana camara	Shrub verbena	0.25	0.25	2.5	4.6	1.1	2.9	8.6
Physalis angustifolia	Ground cherry	0.25	0.37	0.5	4.6	1.6	0.6	6.8
Lippia nodiflora	Frogbit	0.37	0.62	1.2	6.7	2.6	1.4	10.7
Portulacca pilosa	Purslane	0.25	0.25	trace	4.6	1.1	—	5.7
Vitis rotundifolia	Wild grape	0.12	0.12	trace	2.2	0.5	—	2.7
Ambrosia artemisiifolia	Ragweed	0.50	1.0	0.5	9.1	4.3	0.6	14.0
Solanum americanum	Night shade	0.25	0.25	trace	4.6	1.1	—	5.7

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 9 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
			Study Site 11[f] (continued)					
Bidens pilosa	Tickseed	0.25	0.62	trace	4.6	2.6	--	7.2
Tillandsia recurvata	Ball moss	0.25	0.87	trace	4.6	3.7	--	8.3
Phytolacca americana	Pokeweed	0.25	0.37	1.0	4.6	1.6	1.2	7.4
Rhynchelytum repens	Red tops	0.37	0.87	trace	6.7	3.7	--	10.4
Chenopodium ambrosioides	Goosefoot	0.25	0.87	0.5	4.6	3.7	0.6	8.9
Crotolaria spectabilis	Rattle boxes	0.12	0.12	trace	2.2	0.5	--	2.7
			Study Site 12[g]					
Ambrosia artemisiifolia	Ragweed	0.77	10.67	13.5	9.8	20.9	24.3	55.0
Ludwigia octovalvis	Primrose	0.33	0.66	0.5	4.2	1.3	0.9	6.4
Lippia nodiflora	Frogbit	0.55	1.55	10.9	7.0	3.0	19.6	29.6
Eupatorium compositifolium	Dog fennel	0.88	21.33	19.2	11.2	41.8	34.5	87.5
Conyza canadensis	Horseweed	0.67	6.40	4.7	8.5	12.5	8.4	29.4
Oenothera laciniata	Evening primrose	0.67	1.11	1.5	8.5	2.2	2.7	13.4
Vigna luteola	Cowpea	0.22	0.22	trace	2.8	0.4	--	3.2
Desmodium canum	Tick clover	0.22	0.44	trace	2.8	0.9	--	3.7
Bidens pilosa	Tickseed	0.55	2.44	2.5	7.0	4.8	4.5	16.3
Pluchea purpurascens	Marsh fleabane	0.22	0.33	0.5	2.8	0.6	0.9	4.3

Note: See footnotes at end of table.

Table 5-28. Vegetational analysis of Big Bend Station, Fifth Quarterly Report, 1975[a] (Sheet 10 of 10)

Scientific name	Common name	Frequency	Density No./m^2	Percent cover	Relative frequency	Relative density	Relative dominance	Importance value
Study Site 12[g] (continued)								
Solidago microcephala	Goldenrod	0.44	1.22	0.6	5.6	0.24	1.0	9.9
Indigoferum hirsutum	Indigo bush	0.22	0.77	0.5	2.8	1.5	0.9	5.2
Cassia fasciculata	Senna	0.11	0.22	trace	1.4	0.4	--	1.8
Solidago sempervirens	Goldenrod	0.22	0.22	trace	2.8	0.4	--	3.2
Scoparia dulcis	Sweet broom	0.44	1.44	0.8	5.6	2.8	1.4	9.8
Eleusine indica	Goose grass	0.11	0.11	trace	1.4	0.2	--	1.6
Solanum americanum	Night shade	0.22	0.33	trace	2.8	0.6	--	3.4
Chloris petraea	Finger grass	0.11	0.11	trace	1.4	0.2	--	1.6
Lepidium virginicum	Peppergrass	0.33	0.55	trace	4.2	1.1	--	5.3
Sporobolus domingensis	Dropseed	0.33	0.55	trace	4.2	1.1	--	5.3
Setaria geniculata	Foxtails	0.22	0.33	0.5	2.8	0.6	0.9	4.3

[a] From Wunderlin and Long (1975b).
[b] Vegetation type: Ruderal.
Quadrat size: 1 x 1.
[c] Vegetation type: Herbaceous.
Quadrat size: 1 x 1.
[d] Vegetation type: Pine-palmetto scrub.
Quadrat size: 1 x 1.
[e] Vegetation type: Ruderal-grazed.
Quadrat size: 1 x 1.
[f] Vegetation type: Old field.
Quadrat size: 1 x 1.
[g] Vegetation type: Abandoned farm land.
Quadrat size: 1 x 1.

Table 5-29. Checklist of species in station 3A (alternative northeast cooling pond area)[a] (Sheet 1 of 2)

Scientific name	Common name
Fourth Quarterly Report, 1975	
Typhalatifolia	Cattail
Digitaria sanguinalis	Crabgrass
Baccharis halimifolia	Salt bush
Amaranthus hybridus	Pigweed
Panicum purpureum	Panic grass
Paspalum urvillei	Vasey grass
Melilotus alba	Sweet clover
Indigofera hirsutum	Indigo
Schinus terebinthifolius	Brazilian pepper
Sonchus asper	Sow thistle
Oenothera laciniata	Evening primrose
Linaria canadensis	Toadflax
Cyperus rotundum	Sedge
Cyperus ligularis	Sedge
Iva frutescens	Iva
Bidens pilosa	Tickseed
Solidago sempervirens	Goldenrod
Rubus trivialis	Blackberry
Sambucus simpsonii	Elderberry
Cenchrus sp.	Sandbur
Solidago microcephala	Goldenrod
Sida acuta	Sida
Andropogon glomeratus	Beard grass
Pluchea rosea	Fleabane
Helenium amarum	Spanish daisy
Chloris petraea	Finger grass
Heterotheca subaxillaris	Camphor weed
Sporobolus sp.	Dropseed
Fifth Quarterly Report, 1975	
Baccharis halimifolia	Salt bush
Bidens pilosa	Tickseed
Schinus terebinthifolius	Brazilian pepper
Iva frutescens	Iva
Pluchea rosea	Fleabane
Cyperus ligularis	Sedge
Melilotus alba	Sweet clover
Cyperus rotundus	Sedge
Eupatorium compositifolium	Dog fennel
Oenothera laciniata	Evening primrose
Typha latifolia	Cattail
Panicum purpureum	Panic grass

Note: See footnote at end of table.

Table 5-29. Checklist of species in station 3A (alternative northeast cooling pond area)[a]
(Sheet 2 of 2)

Scientific name	Common name
Fifth Quarterly Report, 1975 (continued)	
Amaranthus hybridus	Pigweed
Digitaria sanguinalis	Crabgrass
Cynodon dactylon	Bermuda grass
Sida acuta	Sida
Solidago microcephala	Goldenrod
Solidago sempervirens	Goldenrod
Sonchus asper	Sow thistle
Galactia elliottii	Milk pea
Cenchrus sp.	Sandbur
Chamaesyce sp.	Spurge
Rhynchelytrum repens	Natal grass
Ludwigia peruviana	Primrose willow
Conyza canadensis	Horseweed

[a] From Wunderlin and Long (1975a).

Table 5-30. Similarity index for study areas[a,b]

Area	Area 1	2	3	3A	4	5	6	7	8	9	10	11	12
1	100	41.9	58.8	47.1	44.7	18.2	0	15.4	9.5	43.8	20.8	31.6	59.7
2		100	41.9	35.5	38.6	13.3	0	4.4	10.3	37.9	19.1	27.5	50.7
3			100	50.0	42.6	30.3	0	15.4	14.3	40.6	20.8	35.1	57.1
3A				100	48.9	27.3	0	7.7	14.3	31.3	4.2	21.1	49.4
4					100	21.7	0	5.1	21.8	37.8	8.1	28.9	50.5
5						100	0	16.0	48.8	22.6	21.7	14.6	24.0
6							100	9.5	0	0	0	0	0
7								100	11.8	12.5	12.5	4.9	13.1
8									100	22.5	9.4	13.7	19.4
9										100	27.3	30.2	41.1
10											100	30.2	17.5
11												100	30.8
12													100

[a] From Wunderlin et al. (1975).

[b] Sorensen's Similarity Index indicates the similarity between study areas based on the number of species they have in common and is expressed as a percentage, according to the following formula:

$$2C100/(A + B)$$

where

A = total number of species in community A.
B = total number of species in community B.
C = total number of species common to both communities.

Table 5-31. Occurrence and numbers of amphibians and reptiles found in different habitats on the Big Bend site[a] (Sheet 1 of 2)

	Habitats														
Species	Power line right-of-way	North-east of cooling pond area	Fresh-water marsh	Palmetto-*Juncus* association	Man-groves	Salt prairie	Palmetto-pine association	Pas-ture	Pas-ture pond	*Myrica-Baccharis* association	Old field	Cosmo-politan	Inter-mittent beach	Minimum number observed	Total habitats
							Amphibians								
Southern toad	X	—	2	—	—	—	—	—	—	—	—	—	—	2	2
Eastern narrow-mouth toad	—	—	50-75	—	—	—	—	—	—	1	—	—	—	51	2
Green tree frog	X	—	10-20	—	—	—	2	—	—	2	—	—	—	14	4
Squirrel tree frog	—	—	—	—	—	—	4	—	—	—	—	—	—	4	1
Bullfrog	—	—	—	—	—	—	—	—	—	1	—	—	—	1	1
Southern leopard frog	1	—	X	—	—	—	—	—	—	—	—	—	—	1	2
							Reptiles								
Green anole	—	—	—	—	—	—	10	—	—	—	—	—	—	10	1
Peninsula cooter	—	—	1	—	—	1	—	—	—	—	—	—	—	2	2
Six-lined race runner	—	—	—	—	—	—	—	—	—	2	—	—	—	2	1
Southern black racer	12[b]	—	X	—	—	—	5	—	—	—	—	—	—	17	3
Eastern indigo snake	—	—	—	—	—	—	—	—	—	2	—	—	—	2	1
Yellow rat snake	X	—	1	—	—	—	—	—	—	—	—	—	—	1	2
Southeastern five-lined skink	2	—	X	—	—	—	—	—	—	1	4	—	—	7	4
Striped mud turtle	—	—	—	—	—	—	—	—	—	2	—	—	—	2	1
Water snake (*Nerodia fasciata* sub-species)	1	—	1	—	—	—	—	—	—	—	—	—	—	2	2
Ground skink	—	—	1	—	—	—	—	—	—	—	—	—	—	1	1

Note: See abbreviation and footnotes at end of table.

Table 5-31. Occurrence and numbers of amphibians and reptiles found in different habitats on the Big Bend site[a] (Sheet 2 of 2)

Species	Habitats														
	Power line right-of-way	North-east of cooling pond area	Fresh-water marsh	Palmetto-*Juncus* association	Man-groves	Salt prairie	Palmetto-pine association	Pas-ture	Pas-ture pond	*Myrica-Baccharis* association	Old field	Cosmo-politan	Inter-mittent beach	Minimum number observed	Total habitats
						Reptiles (continued)									
Box turtle (Florida or Gulf Coast)	—	—	X	—	—	1	—	—	—	—	—	—	—	1	2
Eastern diamondback rattlesnake[c]	—	—	—	—	—	X	2	—	—	—	—	—	—	2	2
Total species 18	7	0	11	0	0	3	5	0	0	7	1	0	0	—	—
Minimum number observed	16	0	66	0	0	2	23	0	0	11	4	0	0	122	

Abbreviation: X = species observed but numbers unavailable.

[a] From Long (1974b) and Wunderlin et al. (1977).
[b] Twelve newly hatched young.
[c] Also observed in a mangrove-salt flat habitat.

Table 5-32. Occurrence and numbers of amphibians and reptiles found in different habitats at Beacon Key, Florida[a] (Sheet 1 of 2)

Species	Habitats													
	Hardwood hammock	Coastal strand[b]	Mangroves	Interior sand flats	Grassland old field	Pine scrub	Saltwater ditches and ponds	Homestead	Shell mounds	Cosmopolitan	Mosquito-control ditch	Temporary pond	Total individuals	Total habitats
Amphibians														
Southern toad	2	2	—	1	—	—	—	—	—	—	—	—	5	3
Eastern narrow-mouth toad	—	2	—	—	—	—	—	4	—	—	—	—	6	2
Green tree frog	—	—	—	2	—	—	—	3	—	1	—	—	6	3
Pine woods tree frog	—	—	—	—	—	2	—	—	—	—	—	—	2	1
Squirrel tree frog	4	2	—	—	—	—	—	—	—	1	—	—	7	3
Greenhouse frog	1	—	—	—	—	—	—	—	—	—	—	—	1	1
Bullfrog	—	—	—	—	—	—	3	—	—	1	—	—	4	2
Southern leopard frog	—	3	—	—	—	—	1	—	2	8	—	—	14	4
Reptiles														
Peninsula cooter	—	—	—	—	—	—	—	—	—	1	—	—	1	1
Gopher tortoise	—	5	—	—	—	—	—	1	—	2	—	—	8	3
Striped mud turtle	—	—	—	—	—	—	1	—	—	—	—	—	1	1
Ornate diamond-back terrapin	—	1	—	—	—	—	—	—	—	—	—	—	1	1
Florida box turtle	1	—	—	—	—	—	—	—	—	—	—	—	1	1
American alligator	—	—	—	—	—	—	7	—	1	6	—	—	14	3
Green anole	1	2	—	—	—	—	2	2	1	3	—	—	11	6
Six-lined race-runner	—	1	—	—	—	—	1	1	8	1	—	—	12	5
Southeastern five-lined skink	3	5	—	—	1	—	—	2	—	—	—	—	11	4
Ground skink	2	—	—	—	—	2	—	—	—	—	—	—	4	2
Southern black racer	—	1	—	—	—	—	—	—	—	—	—	—	1	1
Eastern diamond-back rattle-snake	1	—	—	—	—	—	—	—	—	—	—	—	1	1
Eastern indigo snake	1	2	—	—	2	1	—	—	—	1	—	—	7	5
Corn snake	—	—	—	—	—	—	—	—	—	1	—	—	1	1
Scarlet kingsnake	—	—	—	—	—	—	—	1	—	—	—	—	1	1
Florida water snake	—	—	1	—	—	—	1	—	—	—	—	—	2	2
Rough green snake	—	—	—	—	—	—	—	1	—	—	—	—	1	1

Note: See footnotes at end of table.

Table 5-32. Occurrence and numbers of amphibians and reptiles found in different habitats at Beacon Key, Florida[a] (Sheet 2 of 2)

Species	Habitats													
	Hardwood hammock	Coastal strand[b]	Mangroves	Interior sand flats	Grassland old field	Pine scrub	Saltwater ditches and ponds	Homestead	Shell mounds	Cosmo-politan	Mosquito-control ditch	Temporary pond	Total indi-viduals	Total habitats
Reptiles (continued)														
Peninsula ribbon snake	--	--	--	--	--	--	1	--	--	--	--	--	1	1
Eastern garter snake	--	--	--	--	--	1	--	--	--	--	--	--	1	1
Total species 27	9	11	1	2	2	4	8	8	4	11	0	0		
Total indivi-duals[c]	16	26	1	3	3	6	17	15	12	26	0	0	125	

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[a] From Long (1975).

[b] A green sea turtle shell was found in this habitat.

[c] Sample size = 15 days.

	Verification period						
Species	Stone and Webster (1972)	Long and Wunderlin (1974,1975)	Wunderlin (1977)	Powerline right-of-way	Northeast of cooling pond area	Freshwater marsh	Palmetto-*Juncus* association
American oystercatcher	-	+	+	-	-	-	-
Semipalmated plover	-	+	+	+	-	-	-
Wilson's plover	+	+	+	-	-	+	-
Killdeer	+	+	+	-	-	+	-
Black-bellied plover	+	+	+	-	-	+	-
Ruddy turnstone	+	+	+	-	-	-	-
Common snipe	+	+	-	-	-	+	-
Spotted sandpiper	+	-	-	-	-	-	-
Greater yellowlegs	-	+	+	-	-	-	-
Lesser yellowlegs	-	+	+	-	-	-	-
Willet	+	+	+	-	-	-	-
Red knot	+	+	-	-	-	-	-
Least sandpiper	-	+	-	-	-	-	-
Dunlin	-	+	-	-	-	-	-
Semipalmated sandpiper	+	-	-	-	-	-	-
Western sandpiper	+	-	-	-	-	-	-
Sanderling	+	-	-	-	-	-	-
Short-billed dowitcher	+	+	+	-	-	-	-
Black-necked stilt	-	-	+	-	-	-	-
Herring gull	+	+	-	-	-	-	-
Ring-billed gull	+	+	+	-	-	-	-
Laughing gull	+	+	+	-	-	-	-
Forster's tern	+	+	+	-	-	-	-
Least tern	-	+	+	-	-	-	-
Royal tern	+	-	-	-	-	-	-
Caspian tern	+	+	-	-	-	-	-
Black skimmer	-	+	+	-	-	-	-
Rock dove	+	-	-	-	-	-	-
Mourning dove	+	+	+	-	-	-	-
Ground dove	+	+	+	-	-	+	-
Great horned owl	-	+	-	-	-	-	-
Chuck-will's-widow	+	-	-	-	-	-	-
Common nighthawk	-	+	+	-	-	-	-
Belted kingfisher	+	+	+	-	-	+	-
Common flicker	+	-	-	-	-	-	-
Pileated woodpecker	-	-	+	+	-	-	+

Note: See footnote at end of table.

Table 5-33. Summary of bird observations in different habitats on the Big Bend site[a]
(Sheet 1 of 3)

	Habitat										
ater sh	Palmetto-*Juncus* association	Mangroves	Salt prairie	Palmetto-pine association	Pasture	Pasture pond	*Myrica-Baccharis* association	Old field	Cosmopolitan	Intermittent beach	Total habitats
	-	-	-	-	-	-	-	-	-	+	1
	-	+	-	-	-	-	-	-	-	-	2
	-	+	-	-	-	-	+	-	-	+	4
	-	-	-	-	+	+	-	+	-	+	5
	-	-	-	-	-	-	+	+	-	+	4
	-	+	-	-	-	-	+	-	-	+	3
	-	-	-	-	-	+	-	-	-	+	3
	-	-	-	-	-	-	-	-	-	+	1
	-	+	-	-	-	+	+	-	-	+	4
	-	+	-	-	-	+	-	-	-	+	3
	-	+	+	-	-	-	+	-	-	+	4
	-	+	-	-	-	-	+	-	-	+	3
	-	+	-	-	-	+	+	-	-	-	3
	-	+	-	-	-	-	+	-	-	-	2
	-	-	-	-	-	-	-	-	-	+	1
	-	-	-	-	-	-	-	-	-	+	1
	-	-	-	-	-	-	-	-	-	+	1
	-	+	-	-	-	-	+	-	-	+	3
	-	-	-	-	-	-	+	-	-	-	1
	-	-	-	-	-	-	-	-	-	+	1
	-	+	-	-	-	-	+	-	-	+	3
	-	+	-	-	-	-	+	-	-	+	3
	-	-	-	-	-	-	-	-	-	+	1
	-	+	-	-	-	-	+	-	-	+	3
	-	-	-	-	-	-	-	-	-	+	1
	-	-	-	-	-	-	-	-	-	+	1
	-	+	-	-	-	-	+	-	-	+	3
	-	-	-	+	-	-	-	+	-	-	2
	-	+	-	+	+	-	-	+	-	+	5
	-	+		+	+	-	-	+	-	+	6
	-	-	-	-	+	-	-	-	-	-	1
	-	-	-	+	-	-	-	-	-	-	1
	-	-	+	+	-	-	-	-	-	-	2
	-	+	-	-	+	-	-	-	-	+	4
	-	-	-	+	-	-	-	+	-	-	2
	+	-	-	+	-	-	-	-	-	-	3

Species	Verification period			Powerline right-of-way	Northeast of cooling pond area	Freshwater marsh	Palmetto-*Juncus* association	Mangr
	Stone and Webster (1972)	Long and Wunderlin (1974,1975)	Wunderlin (1977)					
Pied-billed grebe	+	-	-	-	-	+	-	-
White pelican	-	+	-	-	-	-	-	+
Brown pelican	+	+	+	-	-	-	-	-
Double-crested cormorant	+	+	-	-	-	+	-	+
Magnificent frigatebird	-	+	-	-	-	-	-	-
Great blue heron	+	+	+	-	-	+	+	+
Green heron	+	+	+	-	-	-	-	+
Little blue heron	+	+	+	-	-	+	-	-
Cattle egret	+	+	+	-	-	+	-	-
Reddish egret	-	+	+	-	-	-	-	+
Great egret	+	+	+	-	-	+	-	+
Snowy egret	+	+	+	-	-	+	-	+
Louisiana heron	+	+	+	-	-	+	-	+
Yellow-crowned night heron	+	-	+	-	-	+	-	-
Least bittern	-	+	-	-	-	-	-	+
Wood stork	-	+	-	-	-	-	-	+
Glossy ibis	-	+	-	-	-	-	-	-
White ibis	-	+	+	-	-	-	-	+
Roseate spoonbill	-	-	+	-	-	-	-	-
Mottled duck	+	+	+	-	-	+	-	-
Blue-winged teal	-	+	-	-	-	-	-	-
Lesser scaup	+	+	-	-	-	+	-	+
Red-breasted merganser	-	+	-	-	-	-	-	+
Turkey vulture	+	-	-	-	-	-	-	-
Black vulture	+	-	-	-	-	-	-	-
Sharp-shinned hawk	-	+	-	-	-	-	-	-
Red-tailed hawk	+	+	+	-	-	-	-	-
Red-shouldered hawk	-	-	+	-	-	-	+	-
Marsh hawk	-	+	-	-	-	-	-	-
Osprey	-	+	+	-	-	-	-	-
American kestrel	+	-	-	-	-	-	-	-
Bobwhite	+	+	+	-	-	+	-	-
Sandhill crane	-	+	-	-	-	-	-	-
Clapper rail	-	+	+	-	-	-	-	+
Common gallinule	+	-	-	-	-	+	-	-
American coot	+	-	-	-	-	+	-	-

Note: See footnote at end of table.

Table 5-33. Summary of bird observations in different habitats on the Big Bend site[a] (Sheet 2 of 3)

Habitat											
Freshwater marsh	Palmetto-*Juncus* association	Mangroves	Salt prairie	Palmetto-pine association	Pasture	Pasture pond	*Myrica-Baccharis* association	Old field	Cosmopolitan	Intermittent beach	Total habitats
+	-	-	-	-	-	-	-	-	-	+	2
-	-	+	-	-	-	-	-	-	-	+	2
-	-	-	-	-	+	-	-	-	-	+	2
+	-	+	-	-	-	-	+	-	-	+	4
-	-	-	-	-	-	-	-	-	-	+	1
+	+	+	-	-	+	+	+	-	-	+	7
-	-	+	-	-	+	-	+	-	-	+	4
+	-	-	-	-	-	+	+	-	-	+	4
+	-	-	-	+	+	-	-	+	-	+	5
-	-	+	-	-	-	-	+	-	-	+	3
+	-	+	-	-	-	-	+	-	-	+	4
+	-	+	-	-	-	-	+	-	-	+	4
+	-	+	-	-	-	-	+	-	-	+	4
+	-	-	+	-	-	-	-	-	-	+	3
-	-	+	-	-	-	-	-	-	-	-	1
-	-	+	-	-	-	-	+	-	-	-	2
-	-	-	-	+	-	-	-	-	-	-	1
-	-	+	-	-	-	-	+	-	-	+	3
-	-	-	+	-	-	-	-	-	-	+	2
+	-	-	-	+	-	-	+	-	-	+	4
-	-	-	-	-	-	+	-	-	-	-	1
+	-	+	-	-	-	-	+	-	-	+	4
-	-	+	-	-	-	-	+	-	-	-	2
-	-	-	-	-	-	-	-	-	+	-	1
-	-	-	-	-	-	-	-	-	+	-	1
-	-	-	-	+	-	-	-	-	-	-	1
-	-	-	-	+	+	-	-	-	+	-	3
-	+	-	-	+	-	-	-	-	-	-	1
-	-	-	-	+	+	-	-	-	-	-	2
-	-	-	-	-	+	-	+	-	-	+	3
-	-	-	-	-	-	-	-	-	+	-	1
+	-	-	-	+	+	-	-	+	-	-	4
-	-	-	-	-	+	-	-	-	-	-	1
-	-	+	-	-	-	-	-	-	-	-	1
+	-	-	-	-	-	-	-	-	-	-	1
+	-	-	-	-	-	-	-	-	-	+	2

Species	Verification period			Powerline right-of-way	Northeast of cooling pond area	Freshwater marsh	Palmetto-*Juncus* association	Mangroves
	Stone and Webster (1972)	Long and Wunderlin (1974,1975)	Wunderlin (1977)					
Red-bellied woodpecker	+	+	-	-	-	-	-	-
Tree swallow	-	+	-	-	-	-	-	-
Rough-winged swallow	-	+	+	-	-	-	-	-
Blue jay	+	+	+	-	-	+	+	+
Common crow	+	-	-	-	-	-	-	-
Fish crow	+	+	+	+	-	+	-	-
House wren	+	+	-	-	-	-	-	-
Carolina wren	+	+	+	-	-	-	-	-
Long-billed marsh wren	-	+	-	-	-	-	-	-
Short-billed marsh wren	-	+	-	-	-	-	-	-
Mockingbird	+	+	+	+	+	+	+	-
Brown thrasher	+	-	-	-	-	-	-	-
American robin	+	+	-	-	-	-	-	-
Eastern bluebird	+	-	-	-	-	-	-	-
Loggerhead shrike	+	+	+	+	-	+	-	+
Starling	+	+	+	-	-	-	-	-
White-eyed vireo	-	+	-	-	-	-	-	-
Yellow-rumped warbler	-	+	-	-	-	-	-	-
Yellow-throated warbler	+	-	-	-	-	-	-	-
Pine warbler	+	-	-	-	-	-	-	-
Prairie warbler	-	+	-	+	-	-	-	+
Palm warbler	+	+	-	+	-	-	-	+
Common yellowthroat	+	+	+	-	-	-	-	-
House sparrow	+	-	-	-	-	-	-	-
Eastern meadowlark	+	+	+	-	-	-	-	-
Red-winged blackbird	+	+	+	-	-	+	+	+
Boat-tailed grackle	+	+	+	+	-	-	-	-
Common grackle	+	+	-	-	-	-	-	-
Cardinal	+	+	+	-	-	+	-	-
American goldfinch	-	+	-	-	-	-	-	-
Rufous-sided towhee	-	+	+	-	-	-	-	-
Swamp sparrow	-	+	-	-	-	-	-	-
Total species 104	65	80	52	8	1	26	6	36

[a]From Stone & Webster Engineering Corporation (1972), Long (1974a,b,c), Wunderlin and Long (1975a), Wunderlin et al. (1975), and Wunderlin et al. (1977).

Table 5-33. Summary of bird observations in different habitats on the Big Bend site[a] (Sheet 3 of 3)

Habitat											
eshwater marsh	Palmetto-*Juncus* association	Mangroves	Salt prairie	Palmetto-pine association	Pasture	Pasture pond	*Myrica-Baccharis* association	Old field	Cosmo-politan	Inter-mittent beach	Total habitats
-	-	-	-	+	+	-	-	-	-	-	2
-	-	-	-	-	+	-	-	-	-	-	1
-	-	-	-	-	+	-	-	-	-	-	1
+	+	+	-	+	-	-	-	+	-	-	5
-	-	-	-	-	-	-	-	-	+	-	1
+	-	-	-	+	+	-	-	-	+	-	5
-	-	-	-	+	-	-	-	+	-	-	2
-	-	-	-	+	-	-	-	-	-	-	1
-	-	-	-	-	-	+	-	-	-	-	1
-	-	-	-	-	-	+	-	-	-	-	1
+	+	-	+	+	+	-	-	+	-	-	8
-	-	-	-	+	-	-	-	-	-	-	1
-	-	-	-	-	+	-	-	-	-	-	1
-	-	-	-	+	-	-	-	+	-	-	2
+	-	+	-	+	+	+	-	+	-	+	8
-	-	-	-	-	+	-	-	-	+	-	2
-	-	-	-	+	-	-	-	-	-	-	1
-	-	-	-	+	+	-	-	-	-	-	2
-	-	-	-	+	-	-	-	-	-	-	1
-	-	-	-	+	-	-	-	-	-	-	1
-	-	+	-	+	-	-	+	-	-	-	4
-	-	+	-	+	-	-	+	+	-	-	5
-	-	-	-	+	-	+	-	+	-	-	3
-	-	-	-	-	-	-	-	-	+	-	1
-	-	-	+	-	+	-	-	+	-	-	3
+	+	+	+	-	+	+	-	+	-	-	7
-	-	-	-	+	+	+	-	-	+	-	5
-	-	-	-	-	+	-	-	-	+	-	2
+	-	-	-	+	-	-	-	-	-	-	2
-	-	-	-	-	+	-	-	-	-	-	1
-	-	-	-	+	-	-	-	+	-	-	2
-	-	-	-	-	-	+	-	+	-	-	2
26	6	36	7	33	28	15	30	19	10	47	

(1975a), Wunderlin et al.

Table 5-34. Birds observed in different habitats at Beacon Key, Florida[a] (Sheet 1 of 4)

Species	Habitat											
	Local status	Hardwood hammock	Coastal strand	Mangroves	Interior sand flats	Saltwater ponds	Homesite	Shell excavation ponds	Saltwater ditch	Temporary rainwater ponds	Right-of-way[b]	Total habitats
Pied-billed grebe	P	-	-	-	-	X	-	X	X	-	-	3
Brown pelican	P	-	X	X	X	X	-	-	-	-	-	4
White pelican	W	-	-	X	-	X	-	-	-	-	-	2
Double-crested cormorant	W	-	X	-	-	X	-	X	X	-	-	4
Anhinga	P	-	-	-	X	X	-	X	X	-	-	4
Mottled duck	P	-	-	X	X	X	-	-	-	X	-	4
Northern shoveler	W	-	-	X	X	X	-	-	X	X	-	5
Blue-winged teal	W	-	-	X	X	X	-	X	X	X	-	6
Green-winged teal	W	-	-	-	X	X	-	-	X	-	-	3
Red-breasted merganser	W	-	-	-	-	X	-	-	-	-	-	1
Hooded merganser	W	-	-	X	X	X	-	-	-	-	-	3
Turkey vulture	P	-	X	-	X	-	-	-	-	-	-	2
Black vulture	P	-	-	-	X	-	-	-	-	-	-	1
Cooper's hawk	W	X	-	-	X	-	-	-	-	-	-	2
Sharp-shinned hawk	W	-	-	-	X	-	-	-	-	-	-	1
Marsh hawk	W	-	X	-	X	-	-	-	-	-	-	2
Red-tailed hawk	P	X	-	-	-	X	-	-	-	-	-	2
Bald eagle	W	X	-	-	X	-	-	-	-	-	-	2
Osprey	P	-	X	X	X	X	-	X	-	-	-	5
Caracara	A	-	X	-	-	-	-	-	-	-	-	1
American kestrel	W	-	-	-	X	-	-	-	-	-	-	1
Bobwhite	P	-	X	-	-	-	X	-	-	-	X	3
Great egret	P	-	X	X	X	X	-	-	-	-	-	4
Snowy egret	P	-	X	X	-	X	-	-	-	X	-	4
Great blue heron	P	-	X	-	X	X	-	X	X	-	-	5
Reddish egret	P	-	X	-	X	X	-	-	-	X	-	4
Louisiana heron	P	-	X	X	-	X	-	X	-	-	-	4
Little blue heron	P	-	-	X	-	X	-	-	X	X	-	4
Green heron	P	-	-	-	-	X	-	X	X	-	-	3
Black-crowned night heron	P	-	-	-	X	X	-	X	-	-	-	3
Yellow-crowned night heron	P	-	-	-	-	X	-	-	-	-	-	1
Least bittern	P	-	-	-	-	-	-	X	-	-	-	1
Wood stork	P	-	-	X	X	X	-	-	-	X	-	4
White ibis	P	-	X	X	X	X	-	-	-	-	-	4
Roseate spoonbill	S	-	-	X	X	X	-	-	-	X	-	4
Clapper rail	P	-	-	-	-	X	-	-	-	-	-	1

Note: See abbreviations and footnotes at end of table.

Table 5-34., Birds observed in different habitats at Beacon Key, Florida[a] (Sheet 2 of 4)

Species	Local status	Habitat										Total habitatr
		Hardwood hammock	Coastal strand	Mangroves	Interior sand flats	Saltwater ponds	Homesite	Shell excavation ponds	Saltwater ditch	Temporary rainwater ponds	Right-of-way[b]	
Common gallinule	P	-	-	-	-	X	-	X	-	-	-	2
American coot[c]	W	-	-	-	-	-	-	-	-	-	-	-
American oystercatcher	P	-	X	-	-	-	-	-	-	-	-	1
American avocet	W	-	-	-	-	X	-	-	-	-	-	1
Black-necked stilt	S	-	-	-	X	X	-	-	-	X	-	3
Black-bellied plover	W	-	X	-	X	X	-	-	-	X	-	4
Semipalmated plover	W	-	X	-	-	X	-	-	-	X	-	3
Wilson's plover	P	-	X	-	X	X	-	-	-	X	-	4
Killdeer	P	-	X	-	X	X	-	-	-	-	-	3
Spotted sandpiper	W	-	X	-	-	X	-	-	-	-	-	2
Willet	P	-	X	-	X	X	-	-	-	X	-	4
Greater yellowlegs	W	-	-	X	X	X	-	-	-	X	-	4
Lesser yellowlegs	W	-	-	X	X	X	-	-	-	X	-	4
Stilt sandpiper	T	-	-	-	X	-	-	-	-	-	-	1
Short-billed dowitcher	W	-	X	-	X	X	-	-	-	X	-	3
Long-billed dowitcher	W	-	X	-	-	X	-	-	-	-	-	2
Red knot	W	-	X	-	-	-	-	-	-	-	-	1
Dunlin	W	-	X	-	-	X	-	-	-	X	-	3
Sanderling	W	-	X	-	-	-	-	-	-	-	-	1
Least sandpiper	W	-	X	-	X	X	-	-	-	X	-	4
Semipalmated sandpiper	W	-	X	-	X	X	-	-	-	X	-	4
Western sandpiper	W	-	X	-	-	-	-	-	-	-	-	1
Common snipe	W	-	-	-	X	X	-	-	-	-	-	2
Herring gull	W	-	X	-	-	-	-	-	-	-	-	1
Ring-billed gull	W	-	X	-	-	X	-	-	-	-	-	2
Laughing gull	P	-	X	-	X	X	-	-	-	X	-	4
Least tern	S	-	X	-	-	X	-	-	-	X	-	3
Forster's tern	P	-	X	-	-	X	-	-	-	X	-	3
Royal tern	P	-	X	-	-	-	-	-	-	-	-	1
Caspian tern	P	-	-	-	X	X	-	-	-	X	-	3
Black skimmer	P	-	X	-	-	X	-	-	-	-	-	2
Mourning dove	P	X	X	-	X	X	X	-	-	-	X	6
Ground dove	P	-	X	-	X	-	X	-	-	-	-	3
Yellow-billed cuckoo	S	X	-	-	-	X	-	-	-	-	-	2
Great horned owl	P	-	X	-	-	-	-	-	-	-	-	1
Barn owl	P	X	X	-	X	-	-	-	-	-	-	3
Chuck-will's-widow	S	-	X	-	-	-	-	-	-	-	-	1
Whippoorwill	W	X	-	-	-	-	-	-	-	-	-	1

Note: See abbreviations and footnotes at end of table.

Table 5-34. Birds observed in different habitats at Beacon Key, Florida[a] (Sheet 3 of 4)

Species	Local status	Habitat Hardwood hammock	Coastal strand	Mangroves	Interior sand flats	Saltwater ponds	Homesite	Shell excavation ponds	Saltwater ditch	Temporary rainwater ponds	Right-of-way[b]	Total habitats
Common nighthawk	S	-	-	-	X	-	X	-	-	-	-	2
Belted kingfisher	W	-	-	-	-	X	X	X	-	-	-	3
Common flicker	P	X	X	-	X	-	X	-	-	-	X	5
Pileated woodpecker	P	X	X	-	-	-	-	-	-	-	-	2
Downy woodpecker	P	-	-	-	-	-	-	-	-	-	X	1
Red-bellied woodpecker	P	X	X	-	-	X	X	-	-	-	-	4
Gray kingbird	S	X	-	X	X	X	-	-	-	-	-	4
Great-crested flycatcher	S	-	-	-	X	X	-	-	-	-	-	2
Eastern wood pewee	T	-	X	-	-	-	-	-	-	-	-	1
Barn swallow	T	-	X	-	-	-	-	-	-	-	-	1
Tree swallow	W	-	-	X	X	-	-	-	-	-	-	2
Blue jay	P	X	X	-	-	X	X	-	-	-	X	5
Fish crow	P	-	X	-	-	-	-	-	-	-	-	1
House wren	W	-	X	-	-	-	-	-	-	-	-	1
Carolina wren	P	X	X	-	-	X	-	-	-	-	X	4
Mockingbird	P	X	X	-	X	X	X	-	-	-	X	6
Gray catbird	W	X	X	-	-	X	-	-	-	-	-	3
Brown thrasher	P	X	-	-	-	X	-	-	-	-	-	2
American robin	W	X	-	-	-	-	-	-	-	-	-	1
Blue-gray gnatcatcher	P	X	X	-	-	X	-	-	-	-	-	3
Ruby-crowned kinglet	W	-	X	-	-	-	-	-	-	-	-	1
Cedar waxwing	W	-	-	-	X	-	X	-	-	-	-	2
Loggerhead shrike	P	X	-	-	X	-	X	-	-	-	-	3
Starling	P	X	-	-	-	-	X	-	-	-	-	2
White-eyed vireo	P	X	X	-	-	X	X	-	-	-	X	5
Black-whiskered vireo	S	-	-	X	-	X	-	-	-	-	-	2
Black-and-white warbler	W	X	-	-	X	X	-	-	-	-	X	4
Ovenbird	T	-	-	-	-	-	-	-	-	-	X	1
Northern parula[c]	S	-	-	-	-	-	-	-	-	-	-	-
Yellow warbler	T	X	-	-	-	-	-	-	-	-	-	1
Cape May warbler	T	X	-	-	-	-	-	-	-	-	-	1
Yellow-rumped warbler	W	X	X	-	-	-	X	-	-	-	-	3
Prairie warbler	P	X	X	-	X	X	-	-	-	-	X	5
Palm warbler	W	X	-	X	X	-	-	-	-	-	-	3
Common yellowthroat	P	X	X	-	-	X	X	-	-	-	X	5
Eastern meadowlark	P	-	-	-	X	-	X	-	-	-	X	3
Red-winged blackbird	P	X	X	-	X	X	X	-	-	-	X	6
Common grackle	P	-	-	-	-	X	-	-	-	-	X	2

Note: See abbreviations and footnotes at end of table.

Table 5-34. Birds observed in different habitats at Beacon Key, Florida[a] (Sheet 4 of 4)

Species	Local status	Habitat										
		Hardwood hammock	Coastal strand	Mangroves	Interior sand flats	Saltwater ponds	Homesite	Shell excavation ponds	Saltwater ditch	Temporary rainwater ponds	Right-of-way[b]	Total habitats
Cardinal	P	X	X	–	–	X	X	–	–	–	X	5
American goldfinch	W	–	X	–	X	–	–	–	–	–	–	2
Rufous-sided towhee	P	X	X	–	–	X	X	–	–	–	X	5
Savannah sparrow	W	–	–	–	X	–	–	–	–	–	–	1
Sharp-tailed sparrow	W	–	–	–	X	–	–	–	–	–	–	1
Bachman's sparrow[d]	P	–	–	–	–	–	–	–	–	–	–	–
Total species		31	60	20	55	70	19	12	9	23	17	
Survey periods	118	15	9	0[e]	9	24	3	2	0[e]	6	1	

Abbreviations:
P = permanent (expected breeder).
S = summer resident only.
W = winter resident only.
T = transient or migrant.

[a] From Long (1974d,e,f, 1975).

[b] Scrub and hardwood communities sampled. Surveyed only during fourth quarter (November 5, 1974 through February 15, 1975).

[c] Reported in final onsite list, but no reference found concerning the habitat of the species or the time it was observed.

[d] Reported in a cosmopolitan habitat but not included in regular sampling transects.

[e] All birds recorded by miscellaneous observations; no transects run.

Table 5-35. Mammals observed on the Big Bend site, 1972[a]

Species	Habitat association: Old field and disturbed areas	Freshwater marsh	Palm-pine-palmetto woodlands	Mangrove, salt grasses	Cosmopolitan	Total habitats
Virginia opossum	-	-	-	-	X	1
Least shrew	X	-	-	-	-	1
Short-tailed shrew	-	-	X	-	-	1
Northern yellow bat	-	-	-	-	X	1
Nine-banded armadillo	X	X	X	-	-	3
Marsh rabbit	-	-	-	-	X	1
Gray squirrel	-	-	X	-	-	1
Hispid cotton rat	X	-	-	-	-	1
Marsh rice rat	X	X	-	-	-	2
Cotton mouse	-	-	X	-	-	1
House mouse	X	-	-	-	-	1
Black rat	-	-	-	-	X	1
Raccoon	-	-	-	-	X	1
Striped skunk	X	-	X	-	-	2
Eastern spotted skunk	X	-	X	-	-	2
Total species 15	7	2	6	0	5	

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[a]From Stone & Webster Engineering Coporation (1972).

Table 5-36. Mammals trapped (including numbers) or sighted at the Big Bend site[a]

Species	Habitat													
	Power station	Power-line right-of-way	North-east of cooling pond area	Fresh-water marsh	Palmetto-*Juncus* association	Mangroves	Salt prairie	Palmetto-pine association	Pas-ture	Pas-ture pond	*Myrica-Baccharis* association	Old field	Total indi-viduals	Total habitats
Small Mammals														
Hispid cotton rat	X	17	12	7	52	5	56	101	23	38	31	52	394	12
Short-tailed shrew	-	-	-	-	-	-	-	4	-	-	2	4	10	3
Marsh rice rat	-	1	-	5	2	12	13	1	-	13	1	-	48	8
Eastern mole	-	-	-	-	X	-	-	-	X	-	-	-	-	2
Norway rat	-	-	-	1	-	-	-	-	-	-	-	-	1	1
Black rat	-	-	-	-	-	6	2	-	-	2	-	-	10	3
House mouse	-	11	6	6	1	-	-	-	1	-	X	18	43	7
Larger Mammals														
Virginia opossum	X	X	X	X	X	X	-	-	-	-	X	X	-	8
Gray fox	-	X	-	-	-	-	-	-	-	-	-	X	-	2
Nine-banded armadillo	-	-	X	-	X	-	-	X	-	-	X	X	-	5
Marsh rabbit	-	-	X	-	-	X	X	X	-	-	-	X	-	5
Eastern cottontail	-	-	-	-	-	-	-	-	X	-	-	-	-	1
Cottontail sp.[b]	-	X	X	X	X	-	X	X	-	X	X	X	-	9
Raccoon	-	X	X	X	-	X	X	X	-	X	X	-	-	8
Total species 13	2	7	7	6	7	6	6	7	4	5	8	8		

Abbreviation: X = species verified but number unavailable.

[a]From Long (1974a,b,c), Wunderlin and Long (1975a,b), Wunderlin et al. (1975), and Wunderlin et al. (1977).
[b]Cottontail sp. listed only when pellets were found or when marsh rabbits and eastern cottontails could not be positively identified.

Table 5-37. Summary of small mammal data from Beacon Key[a]

Species	Habitats/total captures[b]																											Total for 2nd, 3rd, and 4th quarters
	Hammock			Coastal scrub			Mangrove			Sand flat			Grassland			Pond A			Homesite			Cosmopolitan			Total			
	2[c]	3[d]	4[e]	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	
Hispid cotton rat	2	-	-	1	-	3	-	-	-	2	1	-	11	-	4	10	-	7	1	1	-	-	-	-	27	2	14	43
Black rat	3	-	-	1	-	-	-	-	-	-	-	-	4	-	2	1	-	3	-	-	-	-	-	-	9	0	5	14
Cotton mouse	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	2	0	0	2
Eastern wood rat	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0	0	1
Marsh rice rat	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	0	0	5
House mouse	-	-	-	-	-	4	1	1	-	-	1	-	-	-	2	-	1	4	-	-	-	-	-	-	1	3	10	14
Norway rat	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	1	2
Old-field mouse	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	0	1	0	1
Total individuals per quarter	7	1	1	2	0	7	6	1	-	2	3	-	15	0	8	11	1	14	1	1	-	1	0	-	45	7	30	
Total individuals for study	9			9			7			5			23			26			2			1						82

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[a] From Long (1974d,e,f, 1975).

[b] Hyphen indicates that no census was taken.

[c] Data from 2nd quarter (June 1-August 15, 1974).

[d] Data from 3rd quarter (August 16-November 15, 1974). There was severe flooding over most of study area during the 3rd-quarter survey.

[e] Data from 4th quarter (November 16, 1974-February 15, 1975).

Table 5-38. Important game species and furbearers whose geographic ranges include the Big Bend site[a]

Game species	Furbearers
Birds	Class A[b]
Bobwhite	Raccoon
Wild turkey[c]	Virginia opossum
Mourning dove	Striped skunk
Common snipe	Eastern spotted skunk (civet)
Waterfowl (approximately 20 species)[d]	Nutria
	Beaver[c]
Mammals	Class B[b]
White-tailed deer[c]	Red fox[e]
Gray squirrel	Gray fox[e]
Fox squirrel	Bobcat[c]
Eastern cottontail	River otter[c]
Marsh rabbit	Class C[f]
Wild boar[c,g]	Florida weasel
Black bear[c,h]	Round-tailed muskrat[c]
Amphibians	
Frogs[i]	
Reptiles	
Turtles[j]	

[a] From Florida Game and Fresh Water Fish Commission (1979).

[b] Essentially no closed season.

[c] Species is not expected on the Big Bend site because of habitat restrictions.

[d] Lesser scaup and ringneck are the most common species in the area (B. Towry, Florida Game and Fresh Water Fish Commission, personal communication). There is no goose season in Hillsborough County.

[e] Foxes cannot be hunted, trapped, or killed in Florida. Only sport chasing by dogs is allowed.

[f] May not be taken at any time.

[g] Species is infrequently hunted but is not considered a game animal in Hillsborough County.

[h] Species is protected in Hillsborough County but is hunted in restricted areas in other parts of Florida.

[i] All frogs are considered game species and, except for species of special status, can be taken throughout the year.

[j] All turtles are game species with no closed season, exceptions being the gopher tortoise, Suwannee cooter, and alligator snapping turtle, which have seasons and bag limits. Softshell turtles are the most frequently hunted species.

Note: No species listed as endangered or threatened by the Federal Government or State of Florida (as regulated by the Florida Game and Fresh Water Fish Commission FGFWFC) may be taken, had in possession, or sold. Species listed under "Species of Special Concern" by the FGFWFC can be taken only under special regulations by the FGFWFC.

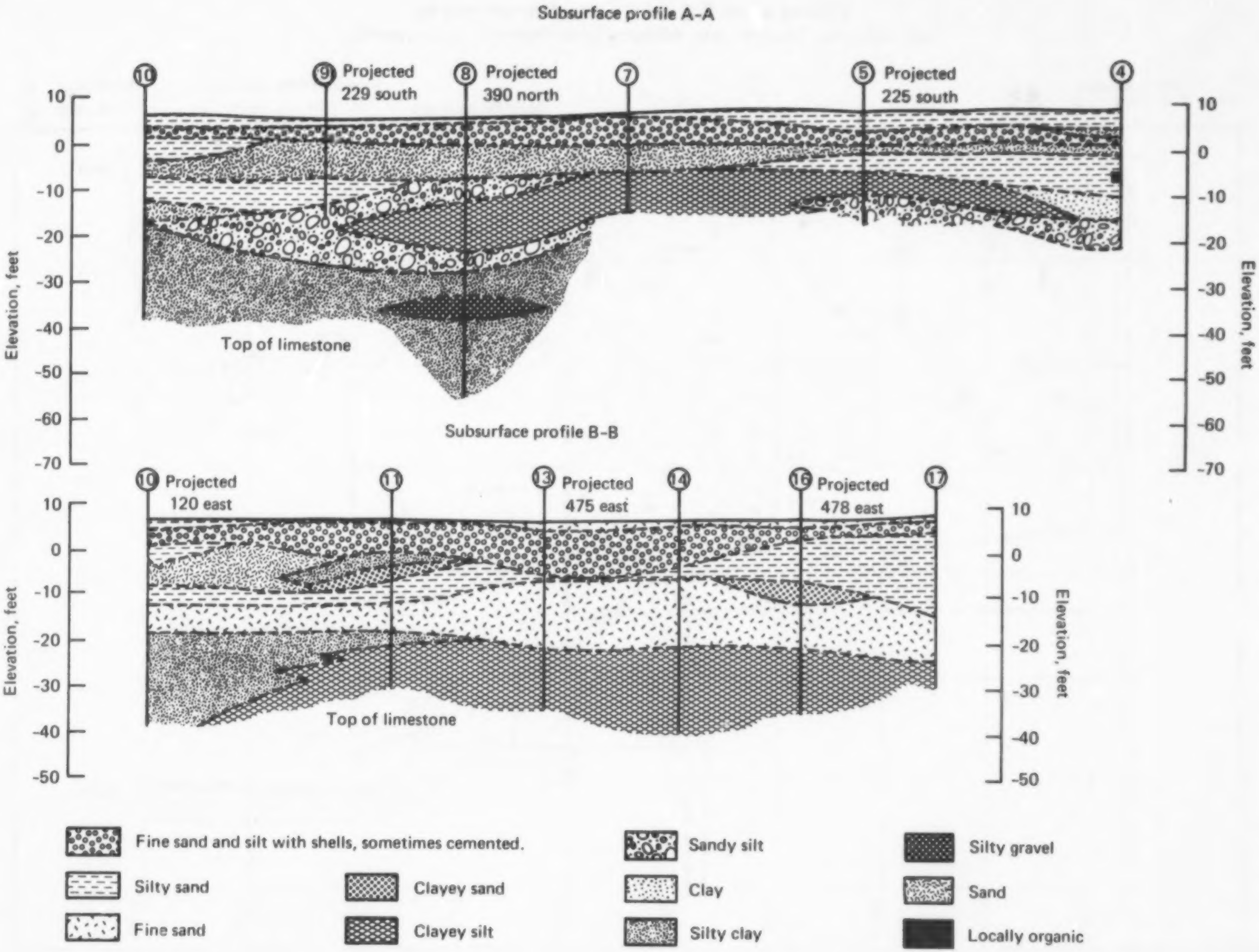

Subsurface profile A-A
10
9
Projected
229 south
8
Projected
390 north
7
5
Projected
225 south
4
Top of limestone
Elevation, feet
10
0
-10
-20
-30
-40
-50
-60
-70
Subsurface profile B-B
10
Projected
120 east
11
13
Projected
475 east
14
16
Projected
478 east
17
Top of limestone
Elevation, feet
10
0
-10
-20
-30
-40
-50
Fine sand and silt with shells, sometimes cemented.
Silty sand
Fine sand
Clayey sand
Clayey silt
Sandy silt
Clay
Silty clay
Silty gravel
Sand
Locally organic

Figure 5-10. Subsurface profile of ash-disposal area of Big Bend Station.

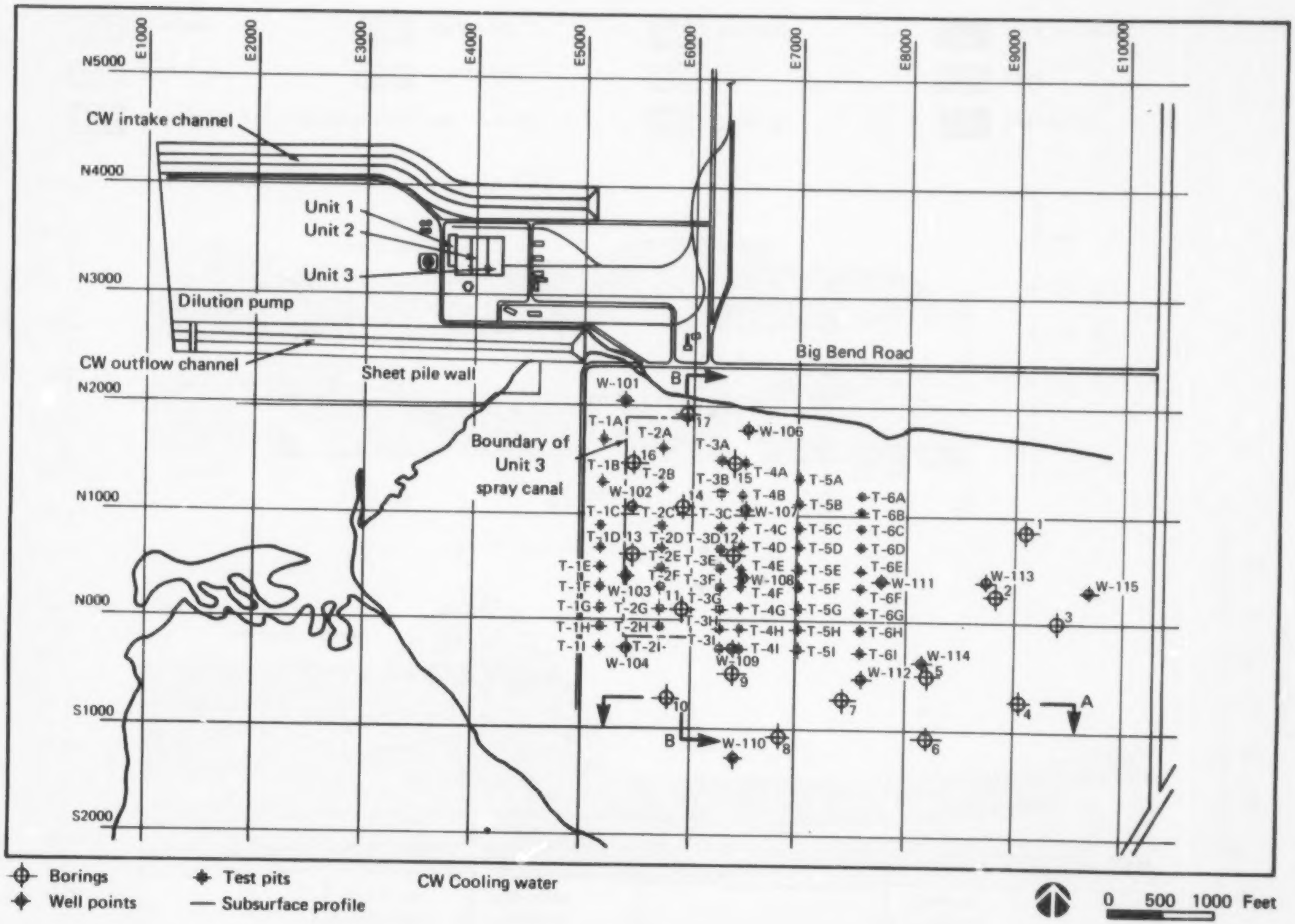
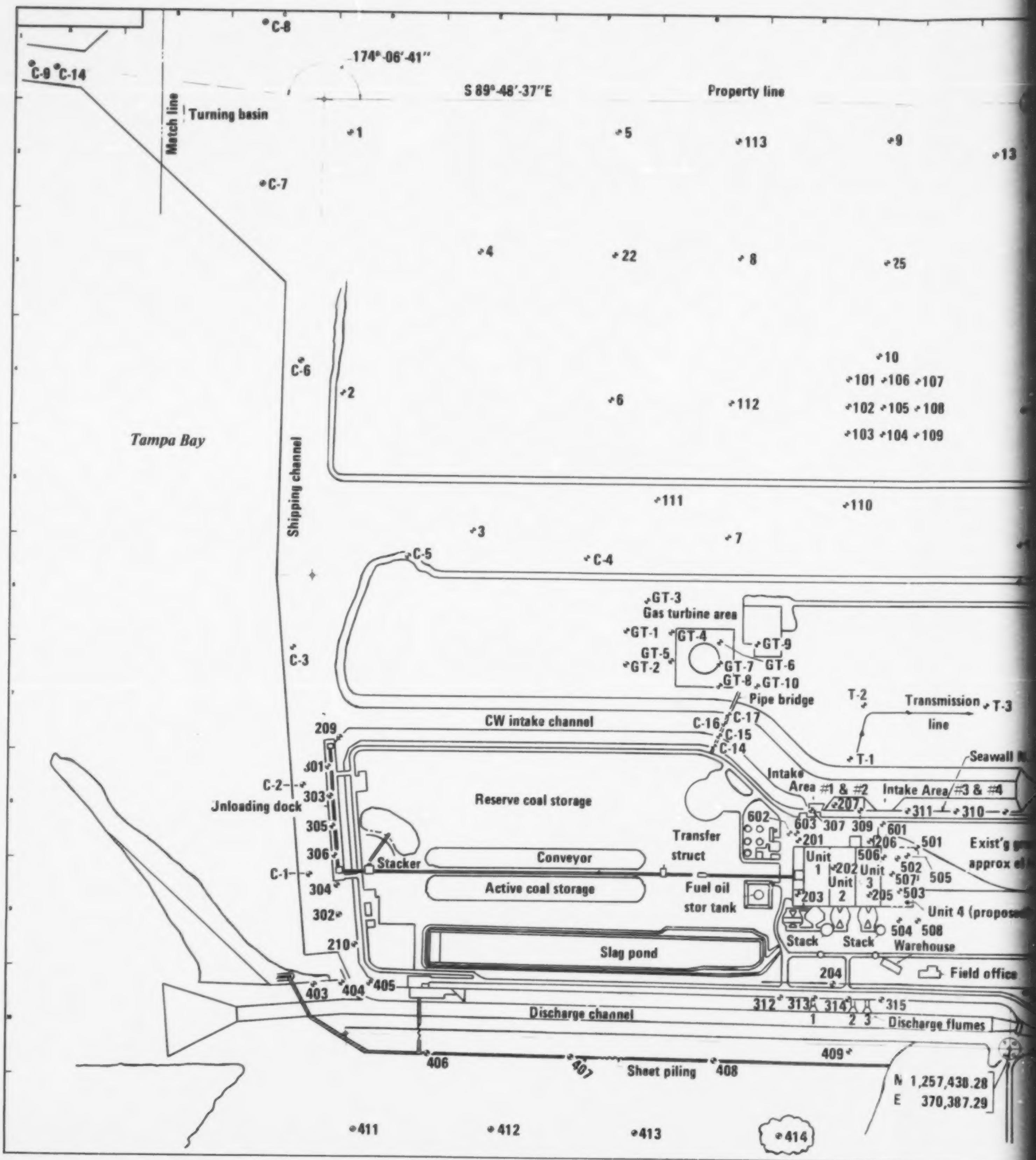

E1000
E2000
E3000
E4000
E5000
E6000
E7000
E8000
E9000
E10000
N5000
N4000
N3000
N2000
N1000
N000
S1000
S2000
CW intake channel
Unit 1
Unit 2
Unit 3
Dilution pump
CW outflow channel
Sheet pile wall
Big Bend Road
Boundary of Unit 3 spray canal
B
A
W-101
W-102
W-103
W-104
W-106
W-107
W-108
W-109
W-110
W-111
W-112
W-113
W-114
W-115
T-1A
T-1B
T-1C
T-1D
T-1E
T-1F
T-1G
T-1H
T-1I
T-2A
T-2B
T-2C
T-2D
T-2E
T-2F
T-2G
T-2H
T-2I
T-3A
T-3B
T-3C
T-3D
T-3E
T-3F
T-3G
T-3H
T-3I
T-4A
T-4B
T-4C
T-4D
T-4E
T-4F
T-4G
T-4H
T-4I
T-5A
T-5B
T-5C
T-5D
T-5E
T-5F
T-5G
T-5H
T-5I
T-6A
T-6B
T-6C
T-6D
T-6E
T-6F
T-6G
T-6H
T-6I
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Borings
Well points
Test pits
Subsurface profile
CW Cooling water
0
500
1000
Feet

Figure 5-11. Locations of borings, well points, and test pits in the ash-disposal area at Big Bend Station.


C-8
C-9
C-14
174°-06'-41"
S 89°-48'-37"E
Property line
Match line
Turning basin
1
5
113
9
13
C-7
4
22
8
25
C-6
2
6
112
10
101
106
107
102
105
108
103
104
109
Tampa Bay
Shipping channel
111
110
3
7
C-5
C-4
GT-3
Gas turbine area
GT-1
GT-4
GT-9
GT-5
GT-2
GT-7
GT-6
GT-8
GT-10
Pipe bridge
C-3
T-2
Transmission line
T-3
209
CW intake channel
C-16
C-17
C-15
C-14
T-1
Seawall
301
C-2
Unloading dock
303
Reserve coal storage
Intake Area #1 & #2
Intake Area #3 & #4
207
311
310
602
603
307
309
601
201
206
501
Exist'g
approx el
305
Transfer struct
306
Stacker
Conveyor
Unit 1
202
Unit 2
506
Unit 3
502
507
505
C-1
304
Active coal storage
Fuel oil stor tank
203
205
503
Unit 4 (propos
302
504
508
210
Slag pond
Stack
Stack
Warehouse
204
Field office
403
404
405
312
313
314
315
Discharge channel
1
2
3
Discharge flumes
406
407
Sheet piling
408
409
N 1,257,438.28
E 370,387.29
411
412
413
414

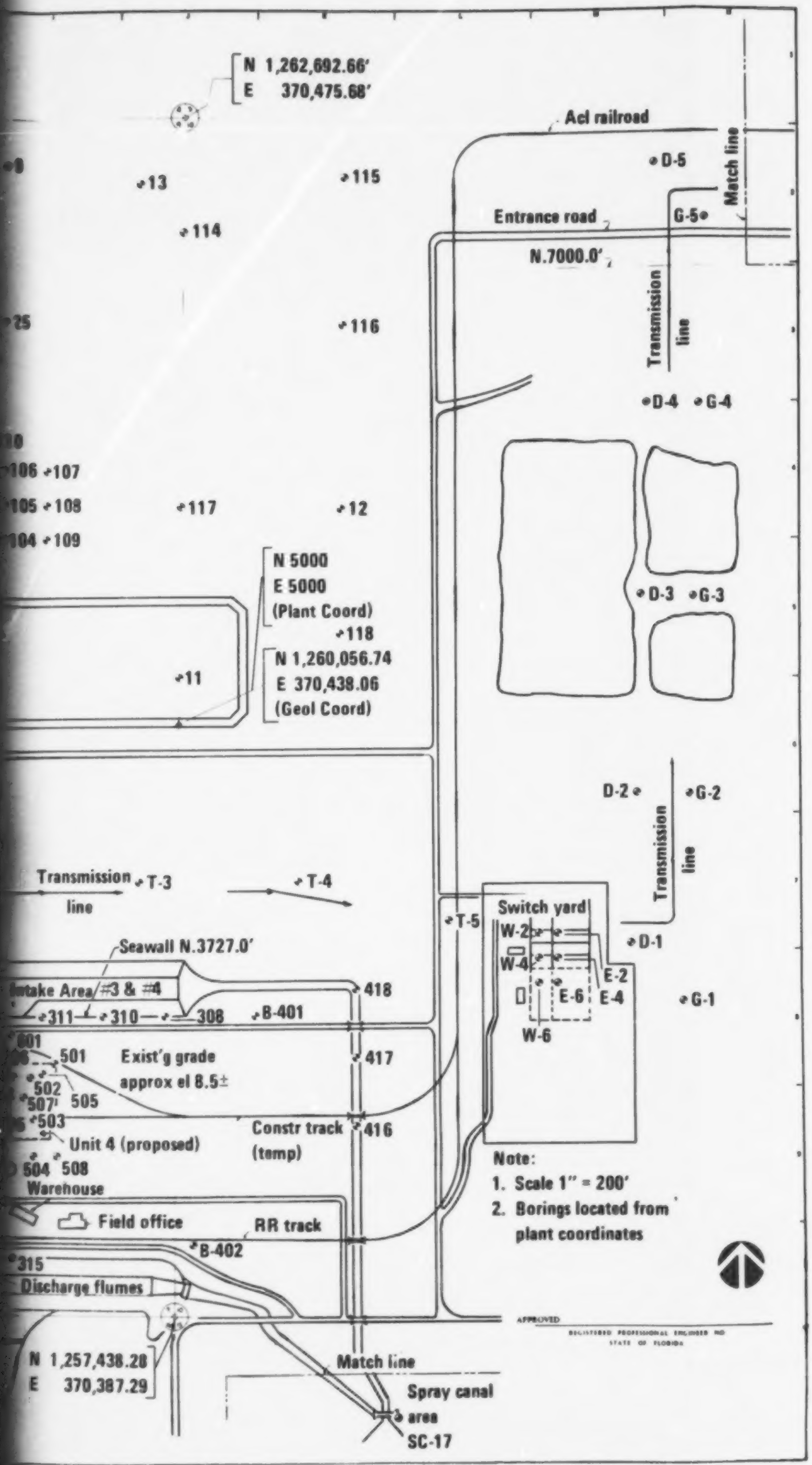

N 1,262,692.66'
E 370,475.68'
Acl railroad
D-5
Match line
Entrance road
G-5
N.7000.0'
Transmission line
13
115
114
25
116
D-4
G-4
106
107
105
108
104
109
117
12
N 5000
E 5000
(Plant Coord)
118
N 1,260,056.74
E 370,438.06
(Geol Coord)
11
D-3
G-3
D-2
G-2
Transmission line
T-3
T-4
Transmission line
T-5
Switch yard
W-2
W-4
E-2
E-4
E-6
W-6
D-1
G-1
Seawall N.3727.0'
Intake Area #3 & #4
311
310
308
B-401
418
601
501
Exist'g grade approx el 8.5±
502
507
505
417
503
Unit 4 (proposed)
Constr track (temp)
416
504
508
Warehouse
Field office
RR track
B-402
315
Discharge flumes
Note:
1. Scale 1" = 200'
2. Borings located from plant coordinates
APPROVED
REGISTERED PROFESSIONAL ENGINEER NO
STATE OF FLORIDA
N 1,257,438.28
E 370,387.29
Match line
Spray canal area
SC-17

Figure 5-12. Boring location plan, Big Bend Station.

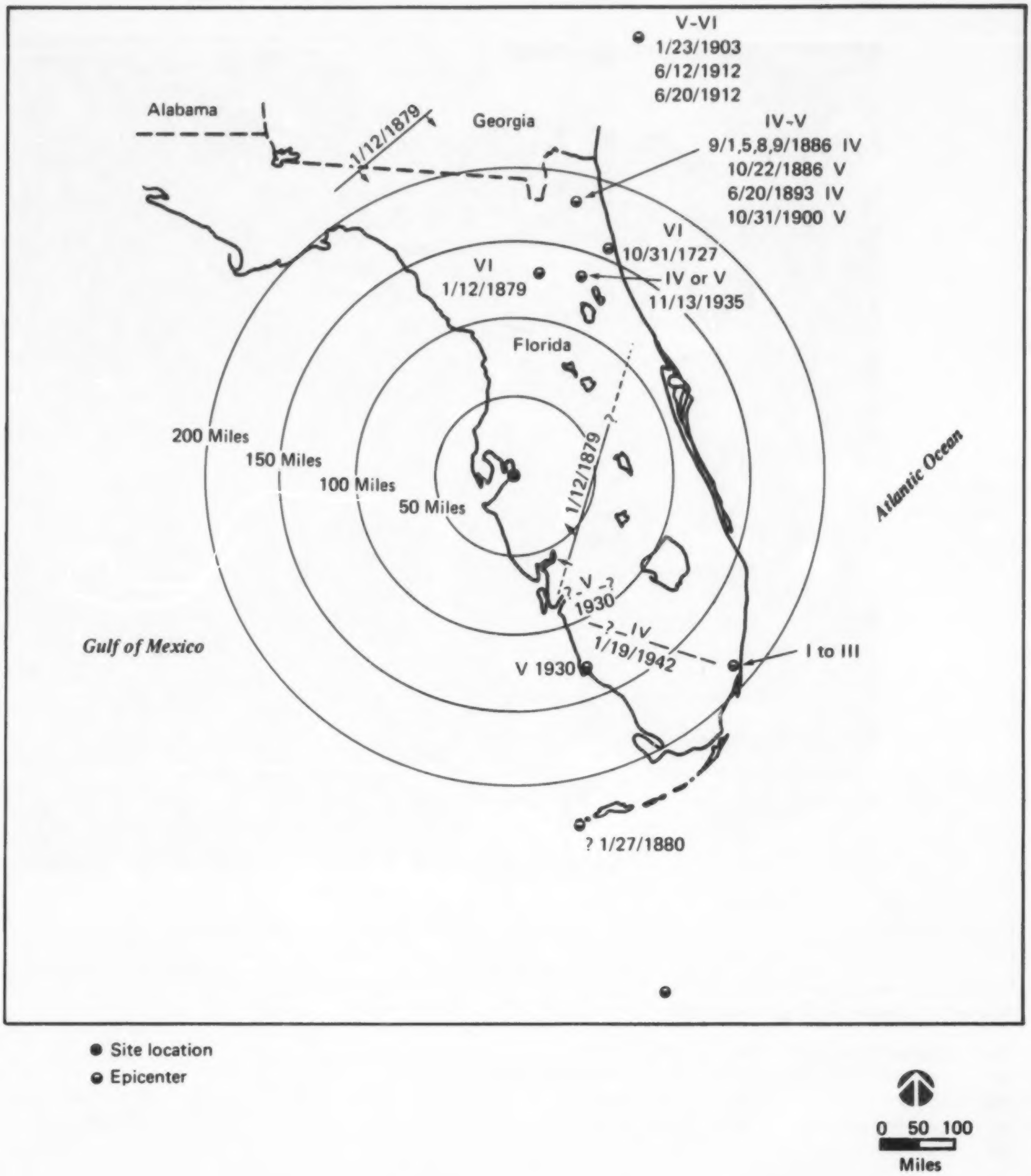
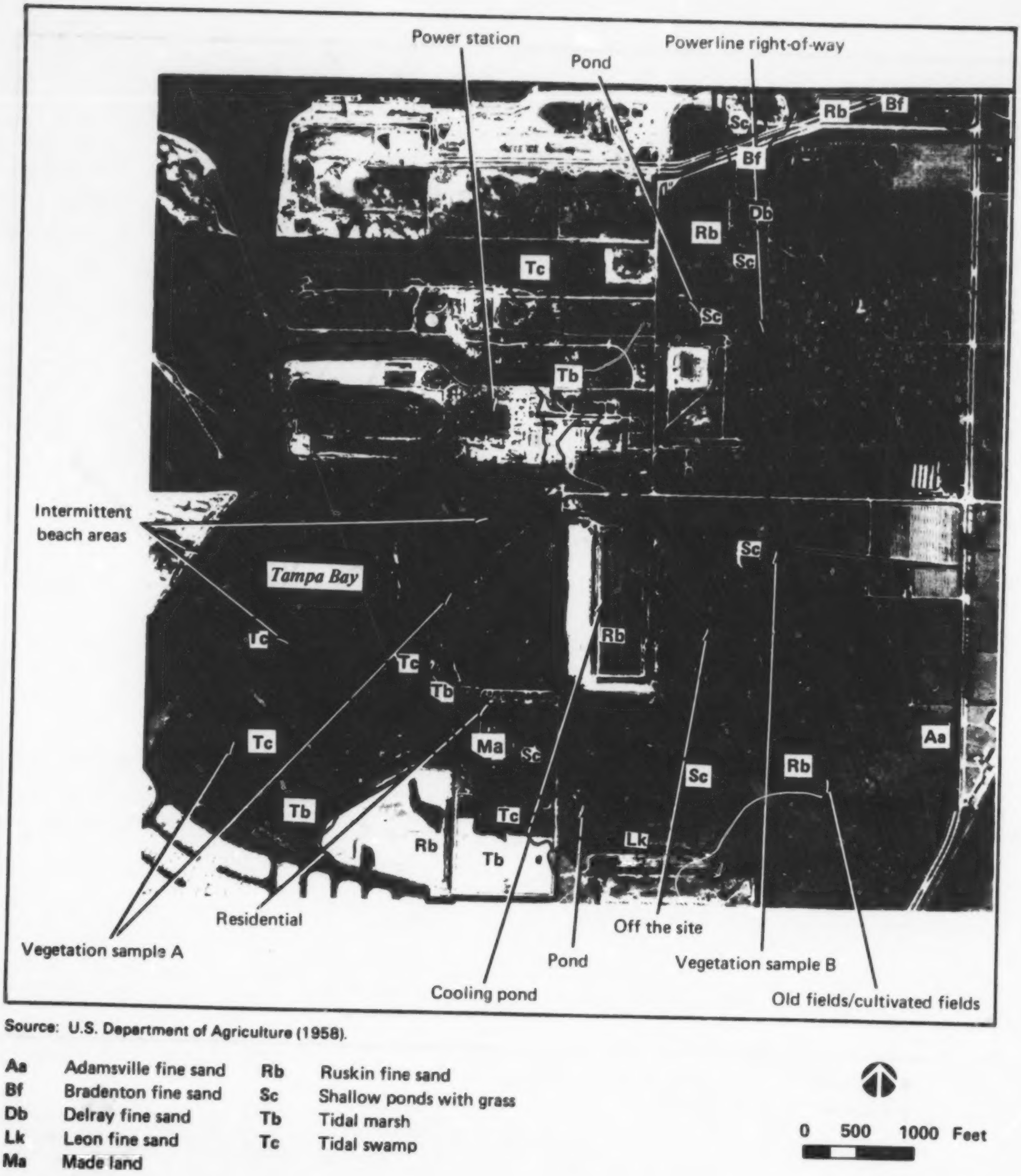
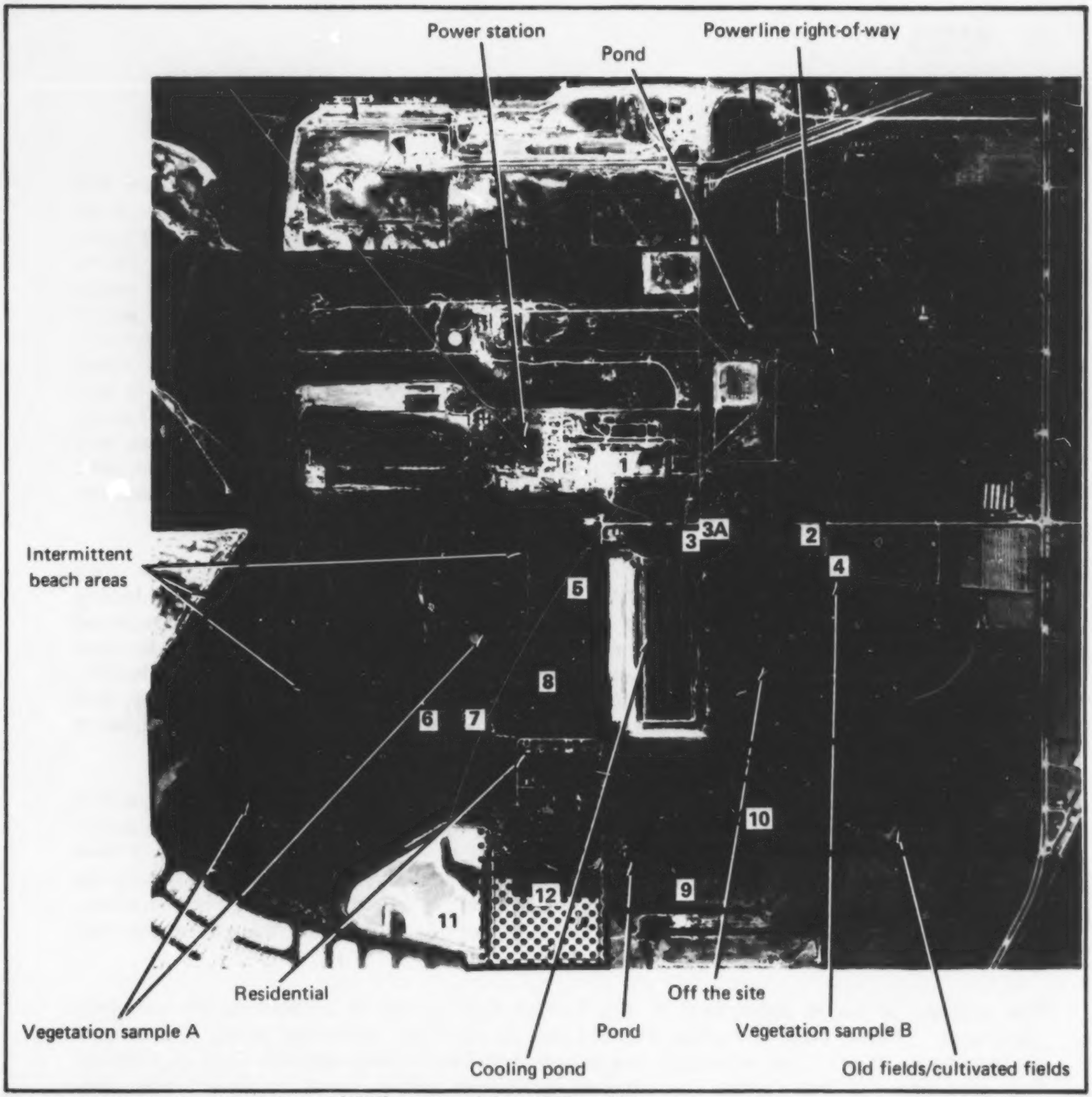

V-VI
1/23/1903
6/12/1912
6/20/1912
Alabama
1/12/1879
Georgia
IV-V
9/1,5,8,9/1886 IV
10/22/1886 V
6/20/1893 IV
10/31/1900 V
VI
10/31/1727
VI
1/12/1879
IV or V
11/13/1935
Florida
200 Miles
150 Miles
100 Miles
50 Miles
?
1/12/1879
Atlantic Ocean
? V ?
1930
? IV
1/19/1942
Gulf of Mexico
I to III
V 1930
? 1/27/1880
Site location
Epicenter
0 50 100
Miles

Figure 5-13. Location of earthquake epicenters in relation to Big Bend Station.


Power station
Pond
Powerline right-of-way
Intermittent beach areas
Tampa Bay
Residential
Vegetation sample A
Cooling pond
Pond
Off the site
Vegetation sample B
Old fields/cultivated fields
Sc
Rb
Bf
Bf
Db
Rb
Sc
Tc
Sc
Tb
Sc
Tc
Rb
Tc
Tb
Tc
Ma
Sc
Tb
Tc
Rb
Tb
Sc
Rb
Aa
Lk
Aa Adamsville fine sand
Bf Bradenton fine sand
Db Delray fine sand
Lk Leon fine sand
Ma Made land
Rb Ruskin fine sand
Sc Shallow ponds with grass
Tb Tidal marsh
Tc Tidal swamp
0 500 1000 Feet

Source: U.S. Department of Agriculture (1958).

Figure 5-14. Soil resources of Big Bend Station.


Power station
Pond
Powerline right-of-way
1
2
3
3A
4
5
6
7
8
9
10
11
12
Intermittent beach areas
Residential
Vegetation sample A
Cooling pond
Pond
Off the site
Vegetation sample B
Old fields/cultivated fields

Source: Classification from Wunderlin et al.(1975); photograph from 1977 overflight.
Power station boundaries of Tampa Electric Company, 1973
"Big Bend Lands" engineering line drawing dated November 8, 1973

1	Ruderal community
2	Powerline right-of-way
3	Successionally advanced ruderal community
3A	Successionally advanced ruderal community
4	Freshwater wetlands
5	Pine flatwoods
6	Mangrove community
7	Mangrove-pine flatwoods transition area
8	Pine flatwoods
9	Pasture
10	Pasture pond
11	Artificial barren land
12	Ruderal community

0 500 1000 Feet

Figure 5-15. Vegetation cover types of Big Bend Station.

5.3 WATER

5.3.1 HYDROLOGY

5.3.1.1 Surface Water

Big Bend Station is 5 miles north of Ruskin, Hillsborough County, Florida, on the eastern shore of Hillsborough Bay. Hillsborough Bay is a northeasterly extension of the Tampa Bay system, which is centrally located on the west coast of Florida (Figure 5-16). The main components of this estuary are Tampa Bay, Old Tampa Bay, Hillsborough Bay, McKay Bay, Boca Ciega Bay, and Terra Ceia Bay, which together make up a surface area of about 350 square miles and have a total shoreline of about 210 miles (Olson and Morrill 1955; Goodell and Gorsline 1961). The Tampa Bay system extends about 35 miles north to south and has a maximum width of about 21 miles east to west. The mean water depth is 11 feet, and 90 percent of the estuary is less than 22 feet deep (Tampa Electric Company 1977b). The drainage area of the Tampa Bay system is estimated to be 2,235 square miles. The freshwater addition to this system originates mainly from the Hillsborough, Alafia, Palm, Little Manatee, and Manatee rivers. The mean annual discharge rate from these rivers and lesser sources is about 1,550 cubic feet per second (cfs) (U.S. Army Corps of Engineers 1974).

Hillsborough Bay is approximately 8 miles long and 4 miles wide with a surface area of about 35 square miles (Goodwin 1977). The average water depth is 10 feet. Shipping channels are maintained in the bay at 34-foot depths but are presently being deepened to 40 feet. Shoreline slopes are gentle. The 6-foot water depth contour is located about 1,200 feet off the west shore and 3,600 feet off the east shore (Tampa Electric Company 1977b). The Hillsborough, Palm, and Alafia rivers drain into this bay, and the total mean annual discharge rate is about 1,120 cfs (U.S. Army Corps of Engineers 1974).

There is considerable variation both of magnitude and of direction in the Tampa Bay system currents. Currents are predominantly tidal, except for occasional wind-induced surface currents. Current velocity at the mouth of the bay sometimes exceeds 6 feet per second (fps) during maximum tidal ebb conditions. Current velocity during maximum tidal flood conditions rarely exceeds 3.5 fps at the mouth of the bay. This relationship of maximum ebb and flood currents is generally observed throughout the bay system (U.S. Army Corps of Engineers 1974).

The pattern of water movement in the Tampa Bay system is predominantly counterclockwise. Flood flow entering the estuary is normally directed along the deeper eastern shore due to the incidence angle between Tampa Bay and the Gulf of Mexico. The presence of Old Tampa Bay in the northwest sector tends to direct ebb flow emanating from this area along the western shore, thus completing the counterclockwise current rotation (U.S. Army Corps of Engineers 1974).

The tidal currents of Hillsborough Bay are generally weak and variable, with the velocity seldom more than 1 fps (Goodwin 1977). There are several spoil banks in the bay that have been created from dredged material. These appear to cause locally erratic current direction and circular currents. A mathematical model of water movement in the bay indicated that several circular currents might exist due to the presence of spoil piles (Ross 1973). A circular movement was predicted just west of the Big Bend Station and south of the spoil islands shown an Figure 5-16. The net movement of water in this area was predicted to be in a counterclockwise direction. Data from a float study just offshore from the Big Bend Station indicated that a counterclockwise current movement was predominant south of the line of spoil islands, while a clockwise current movement existed to the north of these islands (Tampa Electric Company 1974).

A model study performed by the U.S. Geological Survey indicated that a predominantly counterclockwise current circulation occurs in Hillsborough Bay. The net water transport model predicted minimal water exchange between Tampa and Hillsborough bays. In apparent contradiction of previous studies, the model predicted a counterclockwise circulation pattern immediately north of the spoil islands, and a clockwise circulation pattern south of the islands (Goodwin 1977).

Tides in the Tampa Bay system are predominantly diurnal with a strong semidiurnal component (i.e., two high tides and two low tides per day). The semidiurnal characteristic increases from the mouth to the head of the estuary (U.S. Army Corps of Engineers 1974). The Tampa Bay system experiences a diurnal tide range from 2 to 2.8 feet, and Hillsborough Bay experiences a diurnal tide range of about 2.8 feet (Ross 1973). The average water level in Tampa Bay is 0.5 feet above mean sea level (+0.5 msl) (U.S. Army Corps of Engineers 1974). The average water level in Hillsborough Bay is +1.4 msl (Tampa Electric Company 1977b). Generally, high tides at the estuary mouth precede those in the upper bay by about 3 hours. Low tides at the estuary mouth generally occur about 4 hours earlier than those in the upper bay. However, the wind effect from climatic frontal activity can produce water level fluctuations of magnitudes equal to or greater than tidal effects (U.S. Army Corps of Engineers 1974).

Tidal exchange creates the principal circulation of Tampa Bay water. The average volume of water in the bay is estimated to be 2,110,000 acre-feet. At extreme low water level, about 3.5 feet below mean tidal level, the volume of water is approximately 1,570,000 acre-feet (Tampa Electric Company 1977b). The average tidal flow at the mouth of Tampa Bay is estimated to be about 900,000 cubic feet per second (cfs; Goodwin 1977). About 25 percent of the tidal ebb flow is permanently removed from Tampa Bay and mixed with Gulf of Mexico water. Approximately 180 days are required to produce a 90 percent reduction in the concentration of a substance in Old Tampa Bay (Ross 1973).

The high-tide and low-tide volumes in Hillsborough Bay are 350,000 acre-feet and 269,000 acre-feet, respectively (Tampa Electric Company 1977b). The average tidal flow is about 90,000 cfs at the mouth of Hillsborough Bay. The circulation in Tampa Bay results in minimal flushing of Hillsborough Bay (Goodwin 1977). Generally, tidal currents of the bay are weak and variable, with maximum tidal currents less than 1 fps.

With the addition of Big Bend Unit 4, the total plant cooling water flow will be approximately 2,148 cfs or about 2 percent of the tidal flow at the mouth of Hillsborough Bay.

Since 1830, 46 hurricanes and other tropical disturbances have passed over or near the Tampa Bay area. Observed extreme tide heights at Tampa are given in Table 5-39. The historical tide-level range between extreme high- and low-tide conditions is about 21.5 feet (U.S. Army Corps of Engineers 1974).

The main surface drainage basins in Hillsborough County are the Hillsborough, Alafia, and Little Manatee river systems. These three rivers have an average combined flow of about 790 cfs and drain about 70 percent of the county. The remainder of the surface flow is drained from land adjacent to the bay by numerous small streams, canals, ditches, and sewers. The three ditches near the Big Bend Station are Sims Branch, Jackson Branch, and Newman Branch.

The total drainage area of the Hillsborough River is estimated to be 646 square miles and the mean annual discharge is about 671 cfs (Ross 1973). During the period 1940-1958, the average discharge of the river was about 270 cfs at a point where the river drains about 220 square miles. The lowest flow recorded during this period was 48 cfs. About 90 percent of the time the flow was greater than 70 cfs, and 10 percent of the time it was greater than 600 cfs. Usually the monthly flow was highest in late summer or early fall and lowest in the late fall or in spring (Menke et al. 1961).

The total drainage area of the Alafia River is about 418 square miles and the mean annual discharge is estimated to be 384 cfs (Ross 1973). During the years 1934-1958, the minimum flow measured about 14 miles upstream from the mouth was about 7 cfs. Ninety percent of the time the flow exceeded 40 cfs, and a flow of 800 cfs or more occurred 10 percent of the time. Usually, the average monthly flow is highest in September and lowest in May (Menke et al. 1961).

The Little Manatee River has a total drainage area of about 205 square miles and an estimated mean annual discharge of 186 cfs (Ross 1973). Between 1940 and 1958, the minimum flow measured about 15 miles upstream from the mouth was about 1 cfs. Ninety percent of the time the flow was 12 cfs or more, and 10 percent of the time it was 480 cfs or more (Menke et al. 1961).

Two additional streams have a significant drainage area and discharge directly to Hillsborough Bay. These are Bullfrog Creek and Palm River.

Bullfrog Creek drains 40 square miles of land in southern Hillsborough County. The average flow is about 28 cfs at a point where the drainage area is 29 square miles. More than 20 percent of the time the flow is less than 1 cfs. The estimated average flow at the mouth of Bullfrog Creek is about 46 cfs (Menke et al. 1961).

Palm River empties into McKay Bay at Tampa and has a total drainage area of about 45 square miles with an estimated mean annual discharge of about 62 cfs (Ross 1973).

5.3.1.2 Ground Water

Ground water in Hillsborough County occurs in a series of unconfined, semiconfined, and confined aquifers composed of undifferentiated surface sands and clays. The water table generally yields about 5 gallons per minute (gpm) in wells driven to 20-foot depths. A major source of this water-table aquifer is local rainfall, with an estimated 700 cfs of precipitation infiltrating into the aquifer. The proposed FGD storage/disposal site is located south and southeast of Big Bend Station. This site has a total available land of about 130 acres. It is drained by Jackson Branch, Newman Branch, onsite ditches, and various man-made saltwater finger canals. The ground surface slopes down toward Hillsborough Bay with average ground elevations of +6-10 msl. The ground-water body under the site has average water table elevations of +5.5-4.0 msl during nondrought periods (Tampa Electric Company 1973). The general direction of ground-water flow is westerly toward Hillsborough Bay. However, available literature suggests that the water table drops considerably during periods of severe drought, and the water body has shown evidence of contamination by inflows of saltwater. The permeabilities of the first 15 feet of soils range from 5×10^{-3} to 10^{-5} cm/s. During a 1973 geotechnical investigation (Tampa Electric Company 1973), the water table along the north edge of the proposed FGD storage disposal area was monitored by means of four shallow wells. The data collected reveals a hydraulic gradient on the order of $6x10^{-4}$ ft/ft. This gradient indicates ground-water flow from east to west. From permeability estimates made during the geotechnical study, the transmissivity of the surficial aquifer is estimated to be 1,060 gallons per day (gpd) per foot and the flow rate is estimated to be on the order of 0.6 gpd per foot of width of the aquifer.

Underlying the water-table aquifer is the shallow artesian aquifer in the sand and limestone beds of the Hawthorn Formation. Generally this aquifer is artesian, with wells yielding up to 500 gpm of relatively poor quality water. Recharge to this aquifer is upward leakage from the Floridan aquifer. The Hawthorne Formation is about 65-feet thick at the Big Bend site.

The artesian Floridan aquifer is composed of a thick sequence of carbonate rocks from the Avon Park Formation to the Tampa Formation. The upper portion of the Ocala Group overlying the Avon Park Formation is a recognized aquitard zone, which, however, does not prevent full hydraulic connection throughout the aquifer. The Tampa and Suwannee Limestones act as a hydrologic unit above the Ocala Group and separate from the carbonate formations underlying the Ocala. Hydraulically connected by solution openings, the Tampa and Suwannee Limestones above the Ocala Group and the Avon Park Formation underlying the Ocala behave as one aquifer except when either system is stressed by large volumes of withdrawal. Relatively thin beds of the top confining zone cover the Floridan aquifer in a discontinuous manner, creating intricate hydraulic conditions. These confining beds are absent from a broad area on the Ocala uplift and from some scattered places locally. The Ocala uplift represents the principal recharge area due to wide exposures of the aquifer rocks. In other land exposures, the aquifer is either locally discharged through springs or recharged depending on the relative position of the potentiometric surface.

The potentiometric surface of the Floridan aquifer generally slopes from the Ocala uplift toward the sea, but it is marked by local mounds and depressions. Thus, wells in lowland areas yield freshwater under artesian conditions, whereas along the coast, where piezometric head is sharply reduced by pumping, seawater intrusion occurs.

Representative values of selected hydrologic parameters for the Floridan aquifer are given in Section 2.3.3.3.

The Floridan aquifer is the principal source of freshwater supply in the state. Ground water is usually withdrawn from the upper reaches of this aquifer. Water wells seldom reach the Avon Park Formation; however, industrial users have frequently tapped this formation. Intensive pumping for agricultural and industrial uses during the last 30 years has resulted in substantial lowering of the potentiometric surface in the densely populated coastal areas, thereby permitting local contamination by seawater. An estimated combined total of 100 cfs of ground water was pumped in Hillsborough County from the various aquifers for industrial, farm, public, and private water supplies in 1961 (Menke et al. 1961). This value increased to about 140 cfs in 1976 (Tampa Electric Company 1979b). The potentiometric surface of the Floridan aquifer, as measured from several onsite wells, is higher than that of the surficial aquifer. The potentiometric surface in a few of these wells is even higher than ground elevation. This eliminates the possibility of any downward recharge of the Floridan aquifer from the surficial aquifer.

Detailed site subsurface soil and rock information pertinent to site ground-water characteristics is presented in Section 5.2.2. This information is based on soil investigations made in the vicinity of the power station and the ash disposal site (Stone & Webster Engineering Corporation 1973).

5.3.2 WATER QUALITY

5.3.2.1 Hillsborough Bay and Big Bend Area

Hillsborough Bay comprises the northeast sector of the Tampa Bay system and is bounded on the west, north, and northeast by Tampa. Numerous heavy industries and port terminals are located along the north and northeast shores of the bay. Three rivers drain into Hillsborough Bay: the Hillsborough, Alafia, and Palm. Hillsborough Bay waters are generally regarded as the most polluted waters of the Tampa Bay system. The pollution is due to sewage treatment plants, numerous industrial pollutants, and large amounts of nutrients, some introduced naturally from rivers and some introduced artificially from various phosphate-related activities. In addition, it is a region of low salinities and high turbidities.

The Big Bend steam electric generating station is located south of Tampa, Florida (lat. 27°47'N.; long. 82°24'W.) at the extreme southeastern tip of Hillsborough Bay (Figure 5-17).

A chemical description of the Tampa Bay system and of Hillsborough Bay was presented in Chapter 2.3.3. Further background information, principally for Hillsborough Bay, is presented below.

5.3.2.1.1 Temperature

The Tampa Bay system has an approximate water temperature range of 10.0°-32.0°C (Dragovich and Kelly 1964), with a mean annual temperature of 22.0°-25.0°C, and a natural high of 36.9°C (Taylor 1973). Hillsborough Bay has a range of 11.2°-35.1°C (Taylor 1973).

Water temperature near the Big Bend site increased after the October 1970 startup of the first unit at Big Bend (Tampa Electric Company, 1975a). A thermal dilution system and Big Bend Unit 2 went into operaton in early 1973, and data collected in/site-monitoring programs indicated that annual means and ranges of water temperature near the site were several degrees higher than the published averages for Tampa Bay (Tampa Electric Company 1979c).

5.3.2.1.2 Salinity

The annual average salinity for Tampa Bay is 29.5 parts per thousand (ppt), with a range of 10-15 ppt at river mouths to 35 ppt near Mullet Key at the entrance to Tampa Bay. Salinity is greatly affected by heavy summer rainfalls and by the magnitude of evaporation. Olsen (1953) gave values for Hillsborough Bay of 20 ppt in the southerly portion and 11 ppt near Tampa.

5.3.2.1.3 Dissolved Oxygen

Dissolved oxygen is generally high except in areas with high biochemical oxygen demand (sites of industrial or domestic pollution or areas with high organic decomposition). The mean annual dissolved oxygen concentration for Hillsborough Bay is ~6 ppm with a range of 1-12 ppm (Saloman and Taylor 1972).

5.3.2.1.4 pH Level

Olsen (1953) recorded an average pH of 8.0 in the Tampa Bay system and 7.9 in Hillsborough Bay. Salomon and Taylor (1972) noted very little variation seasonally or geographically in Tampa Bay and reported a Hillsborough Bay mean of 8.0 and a range of 7.2-8.6.

5.3.2.1.5 Turbidity

Taylor (1973) reported a mean annual turbidity of 9.0 Jackson turbidity units (JTU) in Tampa Bay and 13.0 JTU in Hillsborough Bay, with a range of 1.7-74 JTU. High turbidity in winter and spring was thought to be caused by high winds that suspend fine bottom deposits.

5.3.2.1.6 Biological Oxygen Demand

Biological oxygen demand is a measure of the amount of oxygen necessary to oxidize compounds degradable by microbial action. Pure waters have BODs of less than 5 mg/ℓ. Waters polluted by organic wastes can have BODs of several hundred mg/ℓ. The Hillsborough County Environmental Protection Commission (1972) reported BOD values in Hillsborough Bay ranging from 0.8-9.3 mg/ℓ, with a mean of 3.1 mg/ℓ. Values in southern Hillsborough Bay were generally 2 mg/ℓ.

5.3.2.1.7 Trace Metals and Pesticides

Data collected by the USGS (Goetz and Goodwin 1980) on the "typical concentration conditions" for trace metals in waters of Hillsborough Bay are included in Figures 2-10 through 2-17.

Data collected by the USGS and summarized by Simon (1974) revealed the following pesticide concentrations in waters of Hillsborough Bay: dichlorophenyldichloroethane, 0.002 ppm; dichlorophenyldichloroethylene, 0.002 ppm; DDT, none detected; dieldrin, none detected; and PCBs, 0.0100 ppm.

5.3.2.1.8 River Pollution

The Alafia is the main source of river pollution. The Alafia River basin is heavily industrialized, and urbanization is fairly extensive. The principal sources of pollution are phosphate mining, nitrogen and phosphorous fertilizer production, agricultural runoff, and domestic sewage.

Fluoride and phosphate are major contributors of pollution to the Alafia River. The average concentration of phosphate in the river from 1967 to 1970 was about 80 ppm. The average fluoride concentration was ~11 ppm during the same period (Hillsborough County Environmental Protection Commission 1972). It is interesting to note that untreated sewage has a typical phosphate concentration of ~45 ppm; therefore, the Alafia River contains almost twice the phosphate concentration of raw sewage. It should be noted that these phosphate levels are being reduced as a result of improved sewage treatment practices.

5.3.2.1.9 Jackson and Newman Branches

Water-quality data collected at several locations in Jackson and Newman Branches are presented in Table 5-40.

Additional water-quality data for Hillsborough Bay are presented in Table 5-41. Table 5-42 presents intake cooling water quality data collected at the Big Bend Powerplant.

5.3.2.2 Ground Water

Communities within a 5-mile radius of the Big Bend site rely on deep wells as a potable water source. Two well fields serving water users in the area are found within the 5-mile radius. The Riverview Water Plant and Well Field, located 4.75 miles northeast of the site, is operated by Hillsborough County and serves the communities of Riverview, Gibsonton, and Gardenville, as well as the Big Bend Station. The Apollo Beach Well Field, two miles south-southeast of the site, serves the Apollo Beach development. The locations of these well fields are shown in Figure 2-10. Water for irrigation in the site area is drawn from individual wells (Hillsborough County Environmental Protection Commission 1972).

Water-quality data for the Floridan aquifer are shown in Table 5-43 and a comparison of the quality of water in the surficial aquifer at the site and in the Floridan aquifer with suggested EPA standards is given in Table 5-44. The latter analysis shows that the surficial aquifer has saline water characteristics. This is evidenced by relatively high concentrations of chlorides (Cl), sodium (Na), sulfates (SO_4), and calcium (Ca), indicating that saline water has mixed with water traveling down gradient in the surficial aquifer.

Water in the surficial aquifer at the site exceeds EPA standards for Cl, SO_4, manganese (Mn), and total dissolved solids (TDS), and exceeds the suggested standards for arsenic (As). As a result, water in this aquifer cannot be used for human consumption without extensive treatment to achieve conformity with EPA recommended limits.

Limited data exist concerning the water quality of the Floridan aquifer at the site. Table 5-44 lists Cl and SO_4 concentrations that are based on average values for several wells in the site area. As can be seen, the SO_4 concentration exceeds recommended drinking water limits.

5.3.3 WATER USAGE

Water usage within 5 miles of the Big Bend site was previously discussed in Section 2.3.4. Rivers and creeks in the area provide sport fishing opportunities but have not been extensively developed for recreation. The bay is used extensively for fishing and boating. Hillsborough and Tampa Bays are also used extensively for shipping.

5.3.4 AQUATIC ECOLOGY

5.3.4.1 Phytoplankton

Phytoplankton studies have been conducted at Big Bend since 1970 on a somewhat irregular schedule and using a variety of sampling procedures and locations.

Phytoplankton collections were made in the Big Bend area from 1970 to 1975. Results of the studies made from June 1972 to May 1974, when the most consistent methodologies were employed, were reported by Tampa Electric Company (1975a). The taxonomic composition and distribution of the phytoplankton community at Big Bend was studied using two techniques: (1) phytoplankton organisms in 1-liter dipped water samples were concentrated by utilizing the phototactic response of the organisms to illumination; and (2) the organisms contained in 20-liter water samples were concentrated by retention on 135-micrometer mesh netting. Diatom and dinoflagellate taxa recorded from the collections are listed in Table 5-45.

From January 1976 to March 1977, phytoplankton collections were made at seven stations (three bay and four intake/discharge locations; Figure 5-18) on an average sampling interval of 19 days (Hughes and Parks 1977). Twenty-liter dipped surface-water samples were collected and then concentrated using 35-micrometer mesh netting. Phytoplankton organisms retained on the netting were preserved, identified, and counted. In addition, measurements of phytoplankton pigments (chlorophyll a and phaeopigments) and total seston biomass were also made.

During the 15-month study period, 133 phytoplankton taxa were recorded from the Big Bend area including 83 diatoms, 42 dinoflagellates, and eight other groups. Table 5-46 lists all phytoplankton taxa collected during 1976-1977, and Table 5-47 lists the 20 most abundant taxa. The ten most abundant taxa comprised more than 90 percent of total phytoplankton abundance in the area. The diatom component accounted for the largest portion of phytoplankton organisms taken with the 35-micrometer mesh. Greatest diatom densities occurred during the winter months, lesser peaks in abundance occurring during late summer and fall. The predominant diatom taxa were Skeletonema costatum, Hemiaulus sinensis, and Rhizosolenia sp. Skeletonema costatum was common throughout the entire study period and was frequently the most abundant phytoplankton taxon. Peak abundance of this species occurred during the fall and winter months. Except for rare occurrences in late summer samples, the presence of H. sinensis was limited to the winter months when it was one of the numerically dominant phytoplankton organisms. Rhizosolenia sp. (identified in the studies as R. delicatula) occurred during most of the study period; this taxon dominated phytoplankton samples collected during late summer, late fall, and early winter.

Planktonic blue-green algae (primarily Oscillatoria sp.) shared dominance with diatoms or dominated phytoplankton numbers from late summer through early fall. This group occurred in relatively low concentrations throughout the remainder of the study period.

Dinoflagellates were most abundant during spring and summer; this group dominated the phytoplankton catch during April and July. During the remainder of the study period, dinoflagellates occurred in relatively low concentrations. The early spring dinoflagellate bloom was attributable to the high abundance of Gonyaulax polygrama, while the mid-summer bloom reflected high densities of Ceratium hircus, which was also the most abundant dinoflagellate taxon throughout the remainder of the study period.

No red tide outbreaks were observed during the 1976-1977 studies, but a few instances of this phenomenon were noted during earlier surveys at Big Bend. In January 1971, isolated blooms of the dinoflagellate Gymnodinium splendens occurred and continued through February of that year, at times turning the color of the water rust-red (Conservation Consultants, Inc. 1971). In late July and early August 1971, Gymnodinium breve was found in plankton samples, coinciding with a red tide caused by that organism in Tampa Bay. The bloom in Tampa Bay caused massive fish kills but prevailing winds kept the heaviest concentrations of the organism and the resultant dead fish away from Big Bend (Tampa Electric Company 1972). In mid-October 1971, powerplant intake canal water was colored dark brown. Microscopic examination of a dipped water sample confirmed the presence of a heavy bloom of the estuarine dinoflagellate Gonyaulax balechii (Tampa Electric Company 1972). There was no evidence of impacts on other flora or fauna caused by this sporadic bloom. Two days later, G. balechii was present in only very limited numbers in the intake and discharge canals as well as at nearshore stations in Tampa Bay.

5.3.4.2 Macrophytes

Several largely qualitative studies of the benthic macrophyte communities in Tampa Bay have included sampling sites in the Hillsborough Bay and Big Bend areas.

During a field survey of benthic macrophyte distribution conducted in Tampa Bay during fall 1960, Phillips (1962) found attached benthic plants generally lacking or in sparse, scattered patches in Hillsborough Bay. In the shallow waters of the Big Bend area, however, shoal grass (Halodule) was common and widgeon grass (Ruppia) abundant; offshore, within the 1-fathom contour, manatee grass (Syringodium) was abundant and Ruppia sparse. Phillips (1960) listed 13 species of macroalgae (including two blue-greens) as occurring in Hillsborough Bay from collections made during 1958 and from other reported occurrences (Table 5-48).

A survey of benthic algal distribution was conducted during 1967-1968 by the Federal Water Pollution Control Administration (1969) as part of an investigation into water quality problems in Hillsborough Bay. Macroalgal diversity was found to be limited compared to other areas of Tampa Bay that were similar hydrographically but free of some of the pollution sources affecting Hillsborough Bay. Principal taxa recorded in the study area were Gracilaria verrucosa, G. foliifera, Ulva lactuca, and Chaetomorpha linum, of which the two species of Gracilaria, a genus whose members are known to proliferate under eutrophic conditions (Humm 1973), accounted for 98 percent of the algal standing crop. Most of the algae were found unattached and free-floating on the bottom.

Benthic macrophytes were occasionally observed in the Big Bend area during the ecological studies conducted in the vicinity of the powerplant beginning in 1970. Information is available for two periods prior to modifications made to the plant discharge canal, 1970-1973 (Tampa Electric Company 1973) and 1975 (Tampa Electric Company 1975b); up to that time the thermal discharge was released directly into the embayment south of the powerplant. In addition, a quantitative study of benthic seagrass distribution in the area was conducted from 1977 to 1978, after the discharge canal was modified to discharge the plant thermal effluent directly into Tampa Bay (Mangrove Systems, Inc. 1977, 1978a, b, 1979).

Macrophyte data collected during the period 1970-1973 include occasional observations made on the mudflats near the powerplant as well as information on macrophytes taken incidentally in fish trawl samples and those impinged on the plant-intake traveling screens (Table 5-49). These observations indicated that benthic macrophytes in the Big Bend area were sparsely distributed and of limited diversity. The seagrass species, Ruppia maritima, and the macroalgal taxa, Gracilaria spp. and Ulva lactuca, were the most commonly reported macrophytes.

During the summer of 1975, a survey was conducted that included collections of benthic macrophytes at three sites within the embayment south of the plant (Figure 5-19). Table 5-50 lists the macrophyte taxa collected during the survey.

Quantitative surveys of benthic seagrass distribution conducted at Big Bend during 1977-1978 were part of a study designed to assess natural revegetation of areas disturbed by construction and operation of the powerplant. Seagrass sampling transects (Figure 5-20) were established in the dilution pump intake canal (B-1), in the embayment south of the discharge canal (A-1, A-2, and A-3), and in a control area located south of the main study area. At quarterly intervals during the 2-year period, seagrass distribution and abundance were assessed. Sampling was conducted at 10-meter intervals along each transect. The distribution of seagrasses in the Big Bend and control areas are compared in Table 5-51 and Figure 5-21.

In the control transect, four seagrass species were observed during the study period: *Ruppia maritima*, *Halodule wrightii*, *Syringodium filiforme*, and *Thalassia testudinum*. Distinct areal zonation and seasonal abundance patterns were evident. The inshore area was dominated by *R. maritima* during March, June, and September, with gradual seasonal replacement and ultimate dominance by *H. wrightii* during December of both years. An apparently new colony of *T. testudinum* was found during December 1977 in a small area seaward of the *Ruppia* and *Halodule* beds; this coverage continued through 1978. The offshore portion of the control transect contained only *S. filiforme*; density and degree of coverage remained fairly constant throughout the study period.

In contrast to the control area, only one seagrass species, *Ruppia maritima*, was observed at the embayment stations. Degree of coverage and abundance varied widely during sampling. *Ruppia* was completely absent at sampling stations during September and December of both study years. Coverage and density were very low during both years on the transect (A-3) located at the former site of discharge of the plant thermal effluent into the embayment. On the transect located near the plant dilution pump intake, only limited coverage of *Halodule wrightii* was observed and this only during June 1977 and September 1978.

The differences noted between the transects located in the control area and in the areas near the plant were suggested to have resulted from past dredge-and-fill activities related to powerplant construction and to other development in the area (e.g., Apollo Beach residential communities), in addition to possible thermal influences from powerplant operation.

5.3.4.3 Zooplankton

Zooplankton investigations of various types have been conducted at Big Bend since 1970. Studies made from 1970 to 1975 were primarily concerned with the general characterization of the plankton community in the vicinity of the powerplant. Results of these studies have been summarized by Tampa Electric Company (1975a). Sampling methodologies varied as the studies evolved but were primarily oriented to the study of phytoplankton organisms. Most collections were taken using whole-water samples and 135-micrometer mesh netting (Section 5.3.4.1). The methodology was sufficient to provide only a qualitative description (e.g., species composition and relative abundance) of the local plankton community; inferences relative to spatial and temporal distributional patterns could not be made.

These studies revealed that the zooplankton community in the area of Big Bend was typically dominated by copepods, of which cyclopoids were generally more abundant than calanoids. Copepod nauplii, pelecypod and gastropod veliger larvae, and polychaete larvae were also abundant. These organisms were collected during every month in at least one of the sampling areas. Other organisms that were seasonally abundant included echinoderm and cirriped larvae, cladocerans, appendicularians, rotifers, and tintinnids. A listing of zooplankton taxa found during the 1970-1975 plankton studies is presented in Table 5-52.

Zooplankton studies were conducted from January 1976 to March 1977 as part of the Big Bend 316 Demonstration investigation for Units 1, 2, and 3 (Phillips et al. 1977; Blanchet, Avery, and Leverone 1977). These studies were concerned with evaluation of the distribution, abundance, and entrainment potential for planktonic stages of fish and benthic invertebrates (meroplankton). Day and night plankton collections were made at approximately 2-week intervals (mean interval = 17 days, range = 13-38 days) at eleven stations in the vicinity of the Big Bend Powerplant (Figure 5-22). Macrozooplankton samples were collected using 363-micrometer mesh plankton nets, which were towed obliquely through the water column.

Eggs from 12 families of fish were collected during the 15-month study (Table 5-53). Two families, Engraulidae and Sciaenidae, accounted for 73 and 26 percent, respectively, of all fish eggs collected. Larvae of 41 species of fish representing 22 families were recorded from the Big Bend collections (Table 5-53). As with eggs, engraulids were the most commonly collected larvae, accounting for 84 percent of all fish larvae collected during the study. Both fish eggs and larvae were taken during every month of the study. Greatest densities occurred during spring and summer, while densities of both developmental stages were lowest during the winter.

The important forage taxon, bay anchovy (*Anchoa mitchilli*), was the most common engraulid in the collections; eggs and larvae of this species were frequently more numerous than planktonic stages of any other fish species. Bay anchovy eggs were first taken in early March and were collected regularly through late October; greatest abundance occurred from April through July. Larvae were collected from late March through early November; peak densities occurred from April through October.

Members of the commercially important family Sciaenidae accounted for 26 and 4 percent, respectively, of all fish eggs and larvae collected during the 15-month study. Sciaenids occurred in relatively large numbers from early March through early November. Egg densities were highest in early April, May, and July. Specific identification of sciaenid eggs and early larvae is generally not possible. However, of those larval stages that could be identified, sciaenids accounted for a larger number of species than any other fish family. Species collected during the study included silver perch (*Bairdiella chrysoura*), sand seatrout (*Cynoscion arenarius*), spotted seatrout (*C. nebulosus*), spot (*Leiostomus xanthurus*), southern kingfish (*Menticirrhus americanus*), northern kingfish (*M. saxatilis*), and black drum (*Pogonias cromis*).

Larval clupeids, carangids, pomadasyids, sparids, and gobiids were also commonly taken in spring and summer collections, although each family accounted for less than 3 percent of all larvae collected. Winter samples were dominated by blenny and goby larvae, but numbers were usually low. Larvae of pinfish (*Lagodon rhomboides*), menhaden (*Brevoortia* spp.), and spot migrated into the study area during January and February. Seasonal occurrence of fish larvae in the Big Bend area during 1976-1977 is presented in Figure 5-23.

A total of 105 invertebrate taxa, of which 86 were decapod crustaceans, were recorded from the meroplankton collections made from 1976 to 1977 (Table 5-54). Two peaks of abundance occurred, one in April and one in October. Larval decapods accounted for 94 percent of the larval invertebrates taken in the collections. Only during winter, when decapod larvae were rare, did other larval taxa make up a large fraction of the 363-micrometer catch. At that time, molluscan larvae dominated the samples. A comparison of the catch of meroplankton organisms made with the 363-micrometer and 76-micrometer mesh nets was made during January 1976. The abundance of cirriped nauplii and gastropod and pelecypod veliger larvae in the 76-micrometer mesh catch was two to four orders of magnitude greater than the abundance of these forms in the 363-micrometer mesh catch. Gastropod veligers and cirriped larvae accounted for 3 and 2 percent, respectively, of meroplankton organisms in the larger mesh collection. Based on this comparison and on the results of other zooplankton studies conducted in the Tampa Bay area using fine mesh nets (Hopkins 1977; Weiss 1978), densities of nondecapod invertebrate larvae taken in the 363-micrometer mesh net are undoubtedly underestimated. These larval invertebrates are typically the numerically dominant meroplankton organisms found in fine-mesh net collections in the Tampa Bay area.

The pinnotherid crab, Pinnixa sayana, was the most abundant larval decapod in the 363-micrometer mesh collections during 1976-1977. Major spawning peaks of this species were evident during April and October, with a smaller peak occurring in July. Larvae of the porcellanid crab, Polyonyx gibbesi, were ranked second in abundance. Large swarms of first- and predominantly second-stage zoeae were noted throughout the Big Bend area during the warm months. Ranked third in abundance were the larvae of the callianassid shrimp, Upogebia affinis, which were most commonly collected during the spring and early summer months. The next most abundant decapod taxa taken in the collections were the xanthid crabs, Neopanope texana and Hexapanopeus angustifrons. Peak spawning activity for both species apparently occurred during late summer and fall in the area.

Commercially important taxa recorded from the larval collections during 1976-1977 included larvae of Menippe mercenaria (stone crab) and Callinectes sp. (blue crab [?]) and postlarvae of Penaeus duorarum (pink shrimp). Although not one of the most abundant xanthid crabs in the meroplankton collections, M. mercenaria larvae commonly occurred from April through October. First-stage zoeae were most abundant (78 percent of all stone crab larvae collected), indicating that spawning occurred locally. Stone crab larval densities observed during the study were somewhat greater inshore than at offshore stations. Seasonally, there were strong peaks in abundance during spring and fall. Larvae of Callinectes sp. were collected only rarely during the study; a few were found between April and September. Postlarvae of P. duorarum occurred in low numbers in the meroplankton collections; most were taken during July and August.

Zooplankton studies conducted at Big Bend during 1979-1980 (Phillips and Blanchet 1980a) concentrated on collection of data on the distribution, abundance, and entrainment potential of meroplanktonic stages of a select group of "Representative Important Species" (RIS) of fish and invertebrates (Table 5-55, list of select taxa). Meroplankton collections were made at five stations located in nearshore and offshore areas in the vicinity of the Big Bend Powerplant (Figure 5-24) using 505-micrometer mesh plankton nets. Two pairs of duplicate net tows were made during both day and night periods at approximately 2-week intervals from February 1979 to February 1980. Additional analyses were conducted on selected samples in order to compare the distribution, abundance, and entrainment potential of the

RIS with that of other meroplankton taxa collected during the study (Phillips and Blanchet 1980b). Replicate samples (three day and three night) were randomly selected from the total of eight samples collected at the intake station (A) during each of eight sampling dates (one per month) between March and October 1979, the period of greatest meroplankton abundance. These select samples were analyzed for both RIS and non-RIS taxa. The data collected give a general idea of the presence and relative abundance of all meroplankton organisms occurring in the 505-micrometer mesh net collections. However, the sampling interval for these select samples (collected approximately one month apart) is too long to describe short-term temporal distribution patterns.

Mean density information for planktonic stages of RIS fish taxa collected during 1979-1980 meroplankton studies is presented in Tables 5-56 through 5-63 and Figures 5-25 through 5-28.

Eggs and larvae of the bay anchovy (*Anchoa mitchilli*) were more abundant in the collections than any other RIS taxon. Both eggs and larvae were taken on all sampling dates between late February and early November with sporatic occurrences of one or the other life stage through January (Table 5-56; Figure 5-25). Mean egg densities were highest from April through July, while larvae were most abundant from April through August. A seasonal shift in location of spawning activity was apparent: from March to June, egg densities were highest at the two stations farthest upbay (D and C); during late June and early July, densities were highest at stations near the plant (A and B); and from mid-July through September, densities were greatest at the southern open bay station (E). This trend was not evident with anchovy larval abundance; densities of this lifestage within the study area were highly variable.

RIS members of the family Sciaenidae that were identified from Big Bend collections during 1979-1980 included: silver perch (*Bairdiella chrysoura*), spotted seatrout (*Cynoscion nebulosus*), and black drum (*Pogonias cromis*). A large number of eggs with characteristics common to the family but not specifically identifiable were grouped as "Unidentified Sciaenid Eggs" (Table 5-57; Figure 5-26). Since at least nine species of this family are known to occur in the Big Bend area, this grouping undoubtedly contains eggs of more than one species. Sciaenid eggs were taken in the collections during all months of the study; greatest densities occurred from April to August. Eggs were generally more abundant at stations in the vicinity of the powerplant (A and B) except from late July through early August, when densities were greatest at offshore Station E. Other RIS taxa identified from the egg collections included *Bairdiella chrysoura* (Table 5-58; Figure 5-27), *Cynoscion* spp. (Table 5-59), and *Pogonias cromis* (Table 5-60). Of these, *B. chrysoura* was the most common. Larvae of *B. chrysoura* (February-September, January; Table 5-57; Figure 5-27), *Cynoscion nebulosus* (March-October; Table 5-61), and *Pogonias cromis* (February-August, January; Table 5-60) were also taken sporadically during the study.

Planktonic stages of the scaled sardine (*Harengula jaguana*) were taken in the collections from April to July (Table 5-62; Figure 5-28). Greatest egg densities occurred from May to June; larvae were most abundant from May to July. Concentrations of eggs were greatest at offshore Station E while larvae were most abundant at this station and at stations located near the plant (A and B).

Larvae of the tidewater silverside (*Menidia beryllina*) occurred rarely in collections made from March to July and in September, January, and February (Table 5-63); eggs of this species are demersal and, therefore, were not expected to occur in the plankton samples. Larvae of this taxon were taken only once at offshore Station E.

Analysis of all ichthyoplankton taxa occurring in the select samples collected from March to October revealed the presence of eggs and larvae of sixteen additional species representing thirteen fish families. Densities of the non-RIS eggs and larvae occurring in the monthly samples are in Tables 5-64 and 5-65. Mean abundance data for all ichthyoplankton taxa (RIS and non-RIS) collected monthly during the 8-month period are presented in Tables 5-66 and 5-67.

Eggs and larvae of the bay anchovy, an RIS taxon, were more abundant than any other fish species in the select samples, accounting for 50 and 74 percent, respectively, of all fish eggs and larvae. Unidentified Sciaenidae accounted for most (48 percent of total fish eggs) of the other fish eggs occurring in the select samples. Additional families represented as eggs in the samples included Soleidae, Carangidae, Clupeidae, and Triglidae. The scaled sardine ranked second in larval abundance, accounting for 16 percent of total fish larvae in the samples. Other species averaging more than 1 percent of total fish larvae from March to October were the feather blenny (Hypsoblennius hentzi, 1.5 percent), and the sand seatrout (Cynoscion arenarius, 1.1 percent).

Other commercially important non-RIS fish taxa that were taken as larvae in the 1979-1980 meroplankton collections include kingfish (Menticirrhus spp., 0.8 percent of all fish larvae occurring in the select samples), sheepshead (Archosargus probatocephalus, 0.2 percent), and pigfish (Orthopristis chrysoptera, 0.04 percent).

Of the invertebrate RIS taxa, only stone crab larvae and pink shrimp postlarvae occurred in the 1979-1980 collections. Larval stages of the eastern oyster (Crassostrea virginica) were present in the water column in the study area, as evidenced by the results of the oyster spat studies (Section 5.3.4.4); however, because the larvae metamorphose at a smaller size than would be captured using plankton nets of 505-micrometer mesh, they were not expected nor did they occur in the collections.

Stone crab zoeae were present in the meroplankton collections from early March through December (Table 5-68; Figure 5-29); greatest densities occurred from April to August. Early zoeal larvae were most abundant at stations near the powerplant. Zoeae were usually least abundant at stations located within and at the mouth of Hillsborough Bay (Stations C and D). Stage I zoeae dominated the catch on all sampling dates at the stations near the plant, suggesting that spawning was occurring nearby. Late-stage zoeal larvae were usually most numerous at the station located in the open waters of Tampa Bay (E).

Postlarvae of pink shrimp (Table 5-69) were first taken in meroplankton samples collected at open bay Station E in May and Stations C, D, and E in June, occurred sporadically at all stations through September, and then were only rarely collected through December. Greatest densities in the area occurred during July and September.

Densities (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton taxa collected monthly from March to October in the select intake station samples are compared in Table 5-70; mean abundance data for all taxa taken in the select samples are presented in Table 5-71.

The invertebrate fraction of the meroplankton taken in the select samples was dominated by the larvae of decapod crustaceans. The most commonly collected taxa were, in order of decreasing abundance, the pinnotherid crab Pinnixa sayana, which accounted for an average 35 percent of larval invertebrates; the xanthid crabs, Eurypanopeus depressus, 19 percent, and Hexapanopeus angustifrons, 9 percent;

the callianassid shrimp Upogebia affinis, 8 percent; and the xanthid RIS taxon Menippe mercenaria, 5 percent. As a group, members of the family Xanthidae accounted for 40 percent of all larval invertebrates in the select samples. Additional xanthid species commonly collected were Rhithropanopeus harrisii, Panopeus herbstii, and Neopanope texana. One additional member of the family, Pilumnus spp., was only occasionally collected.

Temporal patterns of abundance of the invertebrate taxa occurring in the select samples are presented in Table 5-70. Greatest total larval invertebrate densities occurred during June. Larvae of Pinnixa sayana were most abundant from May to July. Larvae of Upogebia affinis were most numerous in May and June samples. Larval stages of the abundant members of the family Xanthidae were most common in samples collected from April to June.

Most (92 percent) of the larvae of Pinnixa sayana occurring in the select samples were zoeae of stages III to V, which were approximately equally represented. In contrast, during the 1976-1977 studies at Big Bend, zoeal stages I and II were most numerous. Factors suggested as possibly responsible for this change in relative importance of the early larval stages included extrusion through the larger net mesh used in the 1979 study (505 micrometers, as opposed to 363 micrometers in 1976-1977) and/or a change in location of primary spawning sites relative to the study area.

For most of the xanthid crab species, the earliest larval stages were the most numerous lifestages found in the select meroplankton samples. Rhithropanopeus harrisii was the exception; the intermediate larval stages (primarily stage III) of this species were most common in the samples. Adults of this species typically spawn in waters of lower salinity than are found in the Big Bend study area (Ryan 1956; Pinschmidt 1963; Sandifer 1972). In contrast, 98 percent of Menippe mercenaria larvae and 79-89 percent of the larvae of the remaining abundant xanthid crabs were stage I zoeae, suggesting that spawning sites for these species are in close proximity to the powerplant. In the case of the stone crab, likely adult habitats are the canals, riprap, and clumps of oysters occurring in the area.

Postlarvae of pink shrimp, an RIS taxon, accounted for less than 1 percent of total invertebrate meroplankton occurring in the select samples. Other penaeid shrimp found in the samples (September) included Sicyonia sp. and Trachypenaeus sp. Larvae of the brief squid (Lolliguncula brevis), which is of commercial value in the Tampa Bay area as bait (Dragovich and Kelly 1962), also occurred in the select samples during April and May.

5.3.4.4 Benthic Invertebrates

Studies conducted in Tampa Bay have indicated that the bay system, in general, supports an abundant and diverse assemblage of benthic invertebrates. However, in Hillsborough Bay and several other subareas of the bay system, dredge-and-fill operations and pollution from domestic and industrial sources have resulted in the presence of soft, highly organic sediments, high biological oxygen demand, and low dissolved oxygen concentrations, conditions which place severe limits on the distribution, diversity, and abundance of benthic invertebrates (Taylor 1970). Benthic surveys conducted beginning in 1963 by the Bureau of Commercial Fisheries (now the National Marine Fisheries Service) revealed that benthic taxa common in other parts of Tampa Bay, such as the brachiopod Glottidia pyramidata, the lancelet Branchiostoma sp., the phoronid Phoronis architecta, the quahog clam (Mercenaria campechiensis), echinoderms, and others were either extremely rare or absent in Hillsborough Bay (Taylor and Saloman 1967, 1968, 1970).

An extensive survey of the benthic molluscan fauna of Hillsborough Bay was conducted during August and September 1963 at 45 stations located throughout the bay (Figure 5-30; Taylor, Hall, and Saloman 1971). Collections were made using a bucket dredge and a rigid-frame net, and mollusks retained on a 701-micrometer screen were studied. Sixty-six mollusk taxa were recorded from the collections; of these, only 36 were represented by living individuals (Table 5-72). Live mollusks were collected at only 26 of the 45 stations sampled. At stations where live individuals were taken, samples always contained one or more of the following species: dwarf surf clam (*Mulinia lateralis*), paper mussel (*Amygdalum papyria*), common eastern nassa (*Nassarius vibex*), and stout tagelus (*Tagelus plebius*). Other common mollusks were the crown conch (*Melongena corona*) and the lunar dove-shell (*Mitrella lunata*). *Mulinia lateralis* was present in 65 percent of all samples that contained live mollusks, while *A. papyria*, *N. vibex*, and *T. plebius* occurred in, respectively, 58, 54, and 35 percent of the samples. On the basis of the occurrence and distribution of these four species, bottom environments within Hillsborough Bay were classified as healthy, marginal, or unhealthy zones (Figure 5-31). Healthy stations were those where indicator species were less than 50 percent of all live mollusk species present. At marginal stations, the indicators represented 50 percent or more of all live species present. Unhealthy stations were those where no living mollusks were collected. The total numbers of living mollusks were generally higher at healthy than at marginal stations. The locations of these zones were related to the degree of man-made alteration that had occurred in each section of Hillsborough Bay. On this basis, 42 percent of the bay bottom was considered unhealthy, 36 percent marginal, and 22 percent healthy. Those areas considered unhealthy were typified by accumulations of sediment that was unsuitable for colonization by benthic infauna. These sediments were either highly organic, anaerobic, fine-grained silts; coarse-grained spoil from channel dredging; or gypsum spoil from the processing of phosphate. No living mollusks were found in this zone. The marginal areas represented a transitional zone between the unhealthy and healthy areas. The marginal zones were limited in the number and diversity of mollusks. The healthy areas supported numerous and diverse species assemblages. The sediments in these areas were primarily fine-grained sand. Most of the healthy stations were near the mouth of Hillsborough Bay. Other observations made during the study point to a significant decline of the benthic habitat in this subarea of Tampa Bay; the presence of extensive dead-shell deposits, for example, indicates that Hillsborough Bay was once the site of a flourishing population of the eastern oyster (*Crassostrea virginica*).

The benthic infaunal communities along transects bisecting the main ship channel at various locations in Tampa Bay (Figure 5-32) were studied during 1973 by Taylor (1974) for the U.S. Army Corps of Engineers. Densities of total infaunal invertebrates and of the annelid and arthropod groups were greater along the transect located near the mouth of Hillsborough Bay (Transect 13) than elsewhere within the bay system. Also, mollusks were most numerous on the central Hillsborough Bay transect (14); however, total invertebrate densities along this transect were the lowest of all areas sampled within the estuary.

Early benthic studies at Big Bend were largely qualitative. Studies from 1970 to 1975 by Tampa Electric Company consultants (Tampa Electric Company 1975a) and others (Virnstein 1972) in the nearshore areas near the Big Bend Powerplant revealed the presence of organism assemblages typical of a highly disturbed estuarine environment. Earliest observations (Tampa Electric Company 1975a) revealed few benthic organisms present inshore, but subsequent sampling indicated gradual recruitment was occurring to the populations in the area. The findings were attributed to the highly disturbed nature of the sediments in the area, likely a result of the extensive dredge-and-fill operations and other construction activities at the powerplant site and in the community of Apollo Beach and nearby waterfront residential areas. The inshore sediments were reported as being fine silt combined with large amounts of what was thought to be fly ash. Open bay areas were characterized by more coarse-grained sediments. Quantitative sampling conducted in 1973-1974 (Tampa Electric Company 1975a) substantiated the conclusions of previous (1970-1973) studies.

Monthly quantitative sampling conducted during 1970-1971 at Big Bend (Virnstein 1972) revealed the presence of a benthic fauna associated with the muddy sediments of the embayment to the south of the plant. This assemblage was distinct from that occurring in offshore areas where sandy sediments predominated.

Epifaunal macroinvertebrates were recorded from seine and trawl surveys conducted quarterly from 1971 to 1975 at stations located near the Big Bend Powerplant (Figure 5-33; Tampa Electric Company 1975a). Tables 5-73 through 5-77 list the relative abundance of the 25 most common organisms (fish and invertebrates) collected at selected stations during the last 2 years of the study, the period when the data were considered by the investigators involved to be most reliable. Macroinvertebrate taxa taken during impingement studies at the plant during 1972-1975 are listed in Table 5-78 (Tampa Electric Company 1975a).

Seine and trawl collections were made from January 1976 to March 1977 as part of the 316 Demonstration studies for Units 1, 2, and 3 (Comp 1977). The stations and the frequency of sampling were somewhat different from those of the 1971-1975 studies. Figure 5-34 shows the stations sampled. Seine stations were sampled monthly and trawl stations were sampled quarterly.

The crown conch (Melongena corona) was the most abundant macroinvertebrate collected by seine during 1976-1977. This species was concentrated primarily on the mudflats of embayment Station SB-10. Young individuals were taken during May and June and from September through February. Peak abundance occurred from September to December. The blue crab (Callinectes sapidus) was collected by seine during all months of the year. Nearly half of those collected were taken at Station SB-10. Macroinvertebrates as a group were most abundant at Station SB-10 and least numerous at Station SB-11.

Only four sets of trawl data were collected during 1976 and 1977, so abundance and distribution patterns were difficult to discern. Table 5-79 lists the total number of macroinvertebrates collected at each station during the study. The high densities occurring at Station TB-13 were attributable largely to the presence of large numbers of tunicates (Molgula sp.) in February 1977. Table 5-80 lists the invertebrate catch, excluding this taxon. Comparative day/night trawling conducted during February 1977 indicated that routine sampling, which was always accomplished during the daylight hours, may have led to an underestimation of organism abundance.

Macroinvertebrate taxa were also taken during impingement studies conducted at the powerplant during 1976-1977 (Peekstok, Page, and Haynes 1977). These are listed, along with seasonal occurrence information, in Table 5-81.

During the aquatic ecology studies conducted at Big Bend during 1979-1980, seine and trawl collections were taken at monthly intervals from March through January (Comp 1980). Seine collections were made at four stations (Figure 5-35) during high tide while trawl samples were collected at five stations (Figure 5-35) during the night hours. The number of select RIS (Table 5-55) collected during the studies are summarized by sampling date in Tables 5-82 and 5-83.

Few pink shrimp (Penaeus duorarum) were collected by seine during the 1979-1980 studies. The low numbers collected were attributed to gear selectivity, type of habitat sampled, and the fact that penaeid shrimp typically burrow within the sediment during the daylight hours. Most pink shrimp were taken in the trawl samples. They were collected during all months of the study but were most abundant from late summer through early winter. Individuals were taken at most stations throughout the year; however, greatest catches were typically taken at the inshore stations.

Most blue crabs were taken in the trawl collections. Greatest numbers occurred during sampling in April in the plant intake canal and at Station D within Hillsborough Bay.

Only one stone crab (Menippe mercenaria) was collected during the study, and it was taken by trawl. The paucity of this species in the collections was attributed to the inaccessibility of typical stone crab habitats to the sampling gear.

Forty-five non-RIS macroinvertebrates representing nine species occurred in the seine collections (Table 5-84). The crown conch was the most abundant taxon, constituting 51 percent of the total non-RIS catch. A total of 983 non-RIS macroinvertebrates representing 25 species were collected by trawl (Table 5-84). The penaeid shrimp (Trachypenaeus constrictus) accounted for 63 percent of the non-RIS catch. This species was collected year-round but was most abundant in December and January. In addition to the non-RIS invertebrate species collected in the trawl samples, seven additional taxa were taken during impingement studies at the plant during 1979-1980. These are also listed in Table 5-84.

Studies of the benthic infaunal invertebrate community in the Big Bend area were also conducted during the 1976-1977 (Mahadevan et al. 1977) and 1979 (Mahadevan, Culter, and Yarborough 1980) ecological investigations. During 1976-1977, collections were made at 22 stations (Figure 5-36), chosen on the basis of proximity to the power-plant discharge and thermal plume. At each station, six replicate sediment samples were collected using a petite Ponar grab sampler.

Those invertebrate organisms that were retained after passing the sediment through a 505-micrometer mesh screen were studied. Analysis of sample data collected throughout the study per indicated that six replicates were sufficient to describe the species composition at each station. At 13 of the stations, collections were made quarterly from February 1976 through February 1977. At nine stations, sampling was conducted at 6-week intervals to provide information on within season variability in community structure.

A total of 337 taxa were recorded from the collections made at Big Bend during 1976-1977 (Table 5-85). Nine species (Table 5-86) accounted for approximately 70 percent of the total number of organisms collected. Generally, the infaunal communities at most stations were dominated by only a few taxa. The bivalve Mysella planulata was most frequently the dominant taxon; this species alone accounted for approximately 27 percent of all benthic invertebrates collected during the study. Seasonal abundance of *M. planulata* varied with station; the possibility of continuous breeding was suggested. Similarly, no specific seasonal abundance pattern was evident for the bivalve species referred to as the *Mulinia-Mactra* complex--in later studies at Big Bend, the identity of this taxon was verified as being *Mulinia lateralis* (Mahadevan, Culter, and Yarbrough 1980)--and the polychaete, *Pseudopolydora* sp. Other dominant taxa, such as the amphipods *Ampelisca abdita*, *A. holmesi* (identified in the studies as *A. vadorum* and *A. verrilli*, respectively), and *Rudilemboides naglei* and the cumacean *Cyclaspis varians*, displayed short-lived seasonal abundance patterns which were apparently related to the opportunistic nature of these species and not to the effects of the thermal effluent. The ostracods *Parasterope pollex* and *Haplocytherida setipunctata* were most abundant during the spring and fall. Temporal fluctuations in distribution of the dominant species were great during the study period, and high variability in both abundance and biomass within seasons was reflected in samples obtained at 6-week intervals.

Two benthic invertebrate taxa, the polychaetes *Nereis succinea* and *Capitella capitata*, which have been suggested as indicators of pollution, thermal and otherwise (Logan and Maurer 1975; Reish 1972), were collected during the study. *Nereis succinea* was an abundant and persistent member of the benthic community at stations located in the plant discharge canal; highest abundance occurred during the summer months. During August, this species accounted for 78 percent of total infaunal density at the site of the plant discharge outfall. Also, the relative abundance of this species at a station (BC-8) located near the mouth of the discharge canal was greatest during August, when it accounted for 8 percent of total abundance. At most of the other stations, this species averaged less than 1 percent of total infaunal density for the study period. Relative abundance of *C. capitata* was greatest at the plant discharge canal stations and at stations in the embayment and finger-fill canals located to the south of the plant. The relative contribution of this species to benthic infaunal density was greatest at the plant discharge outfall during April and May 1976, when it accounted for 41 percent and 21 percent, respectively, of total density. The density of *C. capitata* was greatest for the study period as a whole at finger-fill canal Station F-3, a location outside the influence of the plant thermal plume but one that was considered to be impacted by the development activity in Apollo Beach.

In studies conducted during 1976-1977, no statistically significant relationships were discerned between various biotic abundance of dominant species, total faunal density, species diversity, and abiotic (water temperature, dissolved oxygen, various sediment parameters) factors tested. However, sediment type is generally considered one of the most important variables influencing the distribution and community characteristics of benthic fauna. Indeed, analysis of data for faunal similarity collected during the study indicated that the distribution of the infaunal assemblages in the Big Bend area was more in response to sediment type than to thermal discharge effects. In addition, analysis of animal/sediment relationships indicated that the dominant benthic invertebrate taxa could be grouped according to preference for one of four broad sediment types.

While no statistically significant relationships were apparent between the various benthic community parameters and the spatial distribution of water temperature, the general trends suggested that a relationship existed between the composition and distribution of the benthic community near Big Bend and the areal extent of the plant thermal plume. Using hydrographic data collected during 1976-1977, three water-temperature zones were delineated in the vicinity of the powerplant: Zone I, a zone of high water temperatures, 2°C above ambient (discharge canal); Zone II, a zone of moderate water temperatures, 2°C above ambient (stations on thermal

Transect BC and some stations in the embayment to the south of the plant discharge canal and near the spoil islands to the northwest of the plant); Zone III, a zone of ambient water temperature conditions (nonthermal Transect E, the intake stations, and some embayment and far-field stations). The extent of these zones likely would vary spatially with changes in season, tidal condition, plant operation, etc. The relation of these hydrographic zones to the plant thermal effluent was somewhat obscured by the occurrence of high water temperatures at the shallow-water stations (e.g., flats in the embayment) that are not directly influenced by the thermal plume.

Comparison of benthic community parameters and abundance of the dominant invertebrate species with water temperature regimes in the three zones suggested that, in general, a relationship existed between benthic community structure and the distribution of the plant thermal plume. Zone I was characterized by high species diversity (the index H' of Shannon and Weaver [1963]) resulting from low faunal densities coupled with low species richness (number of species and the index d of Margalef [1958]), high equitability, and low oligomixity (defined in the study as the dominance of the community by a single species). The combination of these conditions is indicative of a "pioneer" community with very little species interaction. In addition, pollution-indicator species occurred in abundance at stations within this zone. Zone II was characterized by the presence, in low numbers, of pollution-indicator species, high faunal density, moderate species diversity and species richness, low equitability, and high oligomixity. Zone III was characterized by very low numbers of pollution-indicator species, moderate faunal density, high species diversity and species richness, high equitability, and moderate oligomixity. Based on conventional inferences on the degree of stress on a benthic community as evidenced by community structure parameters, Zone I was characterized as being severely stressed, Zone II as being mildly stressed, and Zone III as being in the natural, unaffected state. Faunal similarity analyses indicated that, in general, the distributions of the invertebrate assemblages in the Big Bend area were more in response to sediment type than to thermal discharge effects.

The results of the studies conducted during 1976-1977 suggested that sediment type was the principal factor controlling the distribution, abundance, and community structure of the infaunal invertebrate assemblages in the vicinity of the Big Bend Powerplant, with the effects of exposure to the plant thermal plume being a secondary factor. The investigators suggested that the influence of sediment type masked that of thermal effects except in the immediate vicinity of the plant discharge.

Studies of the benthic infauna were conducted during 1979 in order to evaluate the ecological effects of shutdown of the Big Bend Powerplant dilution cooling system (Mahadevan, Culter, and Yarbrough 1980). Samples were collected using the same gear (petite Ponar grab), the same basic methods, and most (11) of the same stations as that used in the 1976-1977 benthic studies. At approximately 6-week intervals from May to December 1979, six replicate samples were collected at each of 14 stations (Figure 5-37).

The benthic invertebrate taxa taken during 1979 are listed in Table 5-87. Data on the temporal and spatial distribution of the most abundant taxa are provided in Table 5-88. The relative composition and distribution of the dominant invertebrates collected in 1979 are compared with the findings of the 1976-1977 studies in Table 5-89.

Comparison of the results of the 1976-1977 and 1979 studies revealed that a dramatic change had occurred in the area. During 1979, the benthic infauna in the Big Bend area was comprised mainly of polychaetes and other deposit feeders. The studies conducted during 1976-1977 revealed an abundance of mollusks and crustaceans. In the earlier study, the following taxa were most abundant: *Mysella* sp. (bivalve mollusk), *Ampelisca abdita* (amphipod), *Parasterope pollex* (ostracod), and *Mulinia lateralis* (bivalve mollusk). Except for high densities of *M. lateralis*, which occurred during December, none of the above species were abundant in the study area during 1979.

Data on the relative abundance and distribution of the dominant species occurring in the 1979 collections at Big Bend are presented in Tables 5-90 through 5-95. In general, the distribution of the dominant taxa at stations in the vicinity of the plant discharge and in the embayment south of the discharge canal (14) differed from that at all other stations studied. The results suggest the presence of "pioneer" conditions at these stations (i.e., an abundance of pollution-indicator and opportunistic species, particularly *Nereis succinea* and *Streblospio benedicti*). Temporal changes in species dominance occurred at open bay stations located both within and outside of the influence of the plant thermal plume, but these were limited to only a few species (e.g., the polychaetes *Mediomastus californiensis*, *Paraprionospio pinnata*, *Glycinde solitaria*, and *Pseudopolydora* sp.). In December, the species composition of the infaunal invertebrates changed dramatically at all stations; *Mulinia lateralis*, which had occurred only rarely prior to December, became the overall dominant species in the study area.

Parameters used to evaluate benthic community structure during 1979 are presented in Tables 5-96 through 5-99 and Figures 5-38 through 5-44. Considerable spatial and temporal variation in faunal density occurred in the study area during 1979. In general, infaunal invertebrates decreased in density from the initial sampling conducted in May; lowest densities generally occurred during August and September. Species richness (number of species per station) generally decreased from high values in May and June to low values during the period from late August to November and values then increased during the month of December. Species diversity (the index H' of Shannon and Weaver [1963]) and equitability (evenness, the index J' of Pielou [1966]) varied in both space and time, but, considering the study area as a whole, values generally increased through early August and then declined through December.

Faunal similarity analysis was performed on the benthic data using the index Cλ of Morisita (1959; values can range from 0, for no similarity, to 1, for a high degree of similarity). The index is used to compare samples for occurring species and for the number of individuals of each species that are common to the samples. Similarity analysis data are presented in Tables 5-100 and 5-101. Spatial and temporal variations in the benthic communities of the study area were evident. The analysis indicates that the discharge canal stations (1, 2, and 3) and the station (14) located in the embayment to the south of the powerplant were generally dissimilar to all other stations. In December, except for Stations 2, 3, 7, and 14, all stations in the study area were similar to each other due to the overwhelming dominance of *Mulinia lateralis*.

A comparison of biotic and abiotic data collected during the 1979 studies at Big Bend revealed several trends. Spatial variations in water temperature (Figures 5-45 and 5-46) appeared to influence benthic community characteristics. Temperatures were generally higher at the discharge (1, 2, and 3) and embayment (14) stations than at open bay stations in the study area. While bottom temperatures recorded at Station 4 were higher than those observed at other open bay stations, perhaps due to proximity to the powerplant discharge, no clear-cut faunal differences were evident between this and other offshore stations in the thermal transect. Therefore, a direct relationship between water temperature and faunal distribution was observable only in areas where water temperatures were highest (i.e., $\Delta T \approx 6^{\circ}C$ above ambient). For the study area as a whole, faunal abundance appeared to be related to temporal temperature patterns. Data collected in both the 1976-1977 and 1979 studies indicated that the greatest density of benthic infaunal invertebrates in the study area occurs from November to April.

Spatial variations in salinity within the study area were minimal during 1979 and were not considered a controlling factor with respect to faunal conditions in the area. However, temporal variations in salinity were noted (Figure 5-47), and these may have influenced the structure of the benthic community. In particular, the extreme reduction in salinity during late August (coupled with high water temperature) may have contributed to the low densities of benthic invertebrates recorded at that time.

Low dissolved oxygen concentrations recorded during the summer months (Figure 5-48) were suggested as a possible additional factor contributing to the low densities of benthic organisms observed during that period.

Sediment type is generally considered the most important factor in benthic faunal distribution. With a few exceptions, bottom sediments were similar at the stations sampled during 1979. Some temporal variations in sediment type were noted at several stations, but there was no clear evidence of faunal disparity attributable to these variations.

Along with the changes in species composition, which apparently have occurred in the study area since the time of the 1976-1977 studies, differences in other community parameters were also evident. Comparative data on seasonal trends in faunal density, species richness, and species diversity and equitability for the 11 stations that were sampled during both studies are presented in Figures 5-49 through 5-59. In general, faunal density and species richness values at all open bay stations were considerably lower than they were in the comparable seasons during 1976. Species diversity and equitability were comparable or greater than in 1976, probably reflecting the reduced dominance of a single species. Differences in species composition and community parameters between the two study years were not restricted to the thermal areas; rather, they appeared to reflect an area-wide change in the benthic community.

The dramatic change in benthic species composition, apparent from the 1979 studies, was viewed as the result of a combination of natural cyclic phenomena and perturbation of the entire Tampa Bay system owing to the extensive dredging activities of the Tampa Harbor Deepening Project. Sediments at most of the stations sampled in 1979 were generally more fine-grained than those reported as being present during the 1976-1977 studies. The high density of the bivalve mollusk Mulinia lateralis, which occurred in the study area during December, has also been noted in other parts of Tampa Bay (J. L. Simon, J. L. Taylor, personal communications cited in Mahadevan, Culter, and Yarbrough [1980]) and this has also been attributed to the dredging activities.

Studies on the rate of spatfall of the commercially important eastern oyster (Crassostrea virginica) were conducted from March 1979 to January 1980 at five stations (Figure 5-60) in the Big Bend area (Blanchet 1980). The findings indicate that spatfall first occurred in April and continued until December (Table 5-102). Heaviest spatfall was in June, with a secondary increase during September and October. Some spatial variability was evident in the data.

5.3.4.5 Fishes

Juvenile and adult fish were collected (in addition to macroinvertebrates, discussed in Section 5.3.4.4) by seine and trawl in the Big Bend area from 1970 to early 1977 and during 1979-1980. Objectives of the earlier studies were to determine the composition and temporal and spatial distribution of the fish community in the vicinity of Big Bend and to evaluate powerplant effects on the community. The 1979-1980 study was designed to provide information on RIS fish (Table 5-55) for the purpose of assessing the potential effects of Big Bend Unit 4.

From 1970 to 1975, seine and trawl collections were made on a quarterly basis (Tampa Electric Company 1975a). Sampling stations varied widely during the period. Those stations sampled with greatest regularity are shown in Figure 5-33. From January 1976 to March 1977, as part of the 316 Demonstration studies conducted at Big Bend for Units 1, 2, and 3, duplicate seine collections were made on a monthly basis at each of six stations, while duplicate trawls were made at quarterly intervals at seven stations (Comp 1977). Station locations are shown in Figure 5-34. A listing of fishes collected at Big Bend from 1972 to 1975 (when identifications were considered by the investigators to be most reliable) and the seasonality of occurrence of each is provided in Table 5-103 (Tampa Electric Company 1976b). Fish species that were among the 25 most abundant organisms (fish and invertebrates) collected at five select seine and trawl stations during the last 2 years of the 1970-1975 studies are listed in Tables 5-73 through 5-77 (Tampa Electric Company 1975a). Fishes taken during impingement studies at the Big Bend Powerplant during 1972-1975 are listed in Table 5-104. The description of the fish community in the Big Bend area provided below relies primarily on results of the 1976-1977 studies; data collected from 1970 to 1975 was used for corroboration.

During 1976-1977, a total of 61,273 fish representing 56 species in 32 families were collected in 180 seine hauls made in the Big Bend area (Comp 1977). The tidewater silverside (Menidia beryllina) was the most common fish taken by seine, and it was followed in relative abundance by the bay anchovy (Anchoa mitchilli) and the longnose killifish (Fundulus similis). Data on the most commonly collected species are provided in Table 5-105. Included are data on relative abundance, size range, water temperature range, period of occurrence, and location at which the greatest numbers were taken. Most of the fish commonly collected in 1976-1977 were also predominant during previous quantitative sampling in the study area (Tables 5-73 through 5-77); exceptions were the sheepshead minnow (Cyprinodon variegatus), spot (Leiostomus xanthurus), and northern kingfish (Menticirrhus saxatilis).

During 1976-1977, most fish were collected in the shallow inshore areas; seine collections made at one station (SB-10), located in the northern embayment formed by Apollo Beach, accounted for 38 percent of all individuals taken in the study. Fish collected at this station were predominantly juvenile striped mullet (Mugil cephalus), spotfin mojarra (Eucinostomus argenteus), and longnose killifish. Juveniles of many different species were often collected concurrently at this station. Somewhat similar observations were made at Stations SB-11 and SB-13. These findings suggest that the areas represented by these three stations serve as nursery areas, the northern embayment apparently being the most important.

The seasonal distribution of fish was generally similar at the different seine stations. With the exception of Station SB-12, greatest abundance occurred during spring and fall; fish were least numerous during winter. Conversely, fish were most abundant during winter at Station SB-12. This station was located near the powerplant discharge, which may have attracted fish during the period of low water temperature.

Overall, the seine studies revealed the transient nature of the fish community in the Big Bend area. Most seine catches were generally dominated by a few species (two to six), but the dominants changed with time. Seasonal influxes of certain species caused shifts in community structure throughout the study period. This phenomenon was particularly pronounced at the "nursery" stations; for example, young striped mullet, spot, pinfish (Lagodon rhomboides), and sheepshead minnow dominated the seine catches at Station SB-10 from December through June and then were replaced by juvenile spotfin mojarra and longnose killifish during the remainder of the year.

Because only four collections were made and all of these were made during daylight hours, the descriptive value of trawl data collected during 1976-1977 is limited. For example, only 2,109 fish were collected in the quarterly trawl sampling conducted at seven stations, compared with approximately 61,000 individuals collected by seine during the same period. Moreover, an experimental set of trawl collections made at night during February 1977 yielded 4,349 fish in fourteen tows. The nighttime collection was thus approximately twice the size of that taken in daytime tows, and yet it required only about one-quarter of the collection effort. For these reasons, it was difficult to interpret abundance and distribution patterns. However, certain trends were apparent: bay anchovies dominated trawl catches during three-quarters of sampling and pinfish were predominant during the remaining quarter of sampling in February 1977. Both of these species were also among the most abundant fishes collected in trawl samples from 1973 to 1975 (Tables 5-75 through 5-77; Tampa Electric Company 1975a).

Fishes taken in impingement collections made at Big Bend during 1976-1977 are listed in Table 5-106 (Peekstok, Page, and Haynes 1977).

Seine and trawl collections were made during 1979-1980 as part of the Big Bend Aquatic Ecology Studies, the purpose of which was to provide ecological data on select fish taxa for assessment of the potential impact of Unit 4 (Comp 1980). Single seine hauls were made at each of four stations (Figure 5-35) every four weeks from March 1979 to January 1980. During the same period, trawl sampling was conducted during the nighttime hours at four stations (Figure 5-35). The numbers of RIS collected during the studies are summarized in Tables 5-82 and 5-83.

Fewer bay anchovies were collected by seine during the study than in 1976-1977. Most of the individuals collected in 1979-1980 were adults in spawning condition; however, in the earlier investigation, which included stations not sampled in 1979-1980, several thousand juveniles were taken. A total of 480 bay anchovies were collected by trawl during 1979-1980. Adults were taken during each sampling trip and were most abundant from November to January. Most individuals were collected in the intake canal during this period.

A total of 862 scaled sardines (Harengula jaguana) were collected by seine, and most (562) were immature individuals taken during May. Ninety-one percent of all individuals were collected at Stations W and X. Only two scaled sardines occurred in trawl samples during the study.

The tidewater silverside was the most abundant (5,661 individuals) and ubiquitous (collected at two to four stations each month) fish collected in seine hauls during

1979-1980; this species comprised 86 percent of the total RIS fish catch. Individuals were least numerous from June to July; the species dominated all other sampling dates. Most individuals (3,319) were collected at Station W. None were taken in the trawl samples.

Silver perch (Bairdiella chrysoura), typically a deep-water species, was not collected by seine but was the most abundant RIS taxon taken by trawl. A total of 1,711 individuals were taken, primarily at Station B. Silver perch were most numerous in June and July, when 1,640 predominantly juvenile specimens were collected. Adults were more prevalent in catches taken during late fall and early winter.

Only one small spotted seatrout (Cynoscion nebulosus) was collected during the study, and it was taken by seine at Station Y in October. Local fishermen have reported a decline in the spotted seatrout catch in the Big Bend area (Comp 1980). This was seen as possibly resulting from the normal cyclic abundance patterns of the population and/or the loss of seagrass habitat in the area.

A total of 46 black drum (Pogonias cromis), all juveniles, and all taken in June at Station Y, were collected by seine. Black drum were never reported at this station in previous studies, but the presence of young individuals in the embayment suggests that the area may serve as a nursery for this species. Fifty-five black drum were collected by trawl. Most were taken from August to December and most were collected at Station B. Black drum are seasonally abundant in both the intake and discharge canals and are often caught by fishermen in large numbers there (Comp 1980).

A listing of the non-RIS taxa collected during 1979-1980 is provided in Table 5-107. A total of 5,416 non-RIS fish representing 47 species were collected by seine. The five most abundant species were longnose killifish (1,181), spot (1,018), pinfish (794), sheepshead minnow (477), and rough silverside (Membras martinica, 386). These species accounted for 71 percent of the non-RIS seine catch. The trawl catch included 3,106 non-RIS fish representing 43 species. The five most abundant species collected were sand seatrout (1,040), pinfish (380), sea catfish (Arius felis, 301), spot (281), and pigfish (Orthopristis chrysoptera, 274). These species comprised 73 percent of the total non-RIS fish catch.

In general, the seasonal trends observed in non-RIS species composition and relative abundance during 1979-1980 are consistent with those observed in previous studies in the Big Bend area. Any differences could be attributed to the natural cyclic variations noted for many estuarine organisms.

Longnose killifish are common inhabitants of the Big Bend area (Comp 1977). This species was collected on each sampling trip during 1979-1980 but was most abundant during the summer months; most individuals (73 percent) were taken at Station Y.

Spot are seasonal inhabitants of the Big Bend area. Young are generally found in inshore areas until they attain a size of approximately 80 millimeters (Kilby 1955; Comp 1977), after which they typically migrate to Gulf of Mexico waters for spawning during the winter and early spring (Springer and Woodburn 1960). The transient nature of this species was evident during 1979-1980. Large numbers of juveniles occurred in the seine collections from March to May, when 98 percent of the total catch was taken. Larger individuals were collected sporadically through November. Spot were also seasonally abundant in the trawl catches. Most individuals (98 percent) were collected between March and August.

Pinfish are also seasonally abundant in the Big Bend area. Young individuals were common inshore during the spring and early summer and the adults apparently migrated to offshore waters to spawn during the winter. Pinfish were taken at all seine stations but were most abundant (74 percent) at Station Y. Both juvenile pinfish and spot were abundant at this station, reflecting the continued importance of the area as a nursery. Pinfish were relatively abundant in the trawl catches from March to early July. Large numbers of individuals were collected at Station E in December and January but were essentially absent from the catches taken at the four other trawl stations at that time. This was viewed as evidence of the migration of this species to higher salinity spawning sites.

Sand seatrout comprised 34 percent of the total trawl catch during 1979-1980. This species first occurred in trawl samples during May (321 individuals) and remained an important component of the catch through October. Most of the individuals taken were juveniles. Sand seatrout were collected primarily in the discharge canal (47 percent) and in the intake canal (24 percent).

The sheepshead minnow historically has been a common inhabitant of the Big Bend area (Comp 1977), particularly at Station Y, where all of the specimens were collected during 1979-1980. More than 87 percent of the individuals collected during the study were taken in June and early July. Summer abundance peaks have been noted previously (Comp 1977).

During 1979-1980, the rough silverside was collected in every month but December and January. No distinct seasonal abundance patterns were apparent. This species is a common inhabitant of shoreline areas at Big Bend.

Sea catfish are year-round residents at Big Bend and in the Tampa Bay area in general. This species was most abundant (32 percent) in the discharge canal during the study, and it was also abundant at Station C (25 percent) throughout much of the year.

Pigfish ranked fifth among the non-RIS fish collected by trawl during 1979-1980. Most individuals (71 percent) were taken at open bay Station E.

5.3.4.6 Aquatic Mammals

5.3.4.6.1 Florida (West Indian) Manatee

The Florida or West Indian manatee, Trichechus manatus, is listed as an endangered species by the Federal Government (44 FR 12, 3,636-3,654). It is also considered endangered by the FGFWFC and is viewed as threatened by the FCREPA. In U.S. waters, manatees are also protected by the Marine Mammal Protection Act of 1972 (16 U.S.C. 1361) and receive protection internationally as well. Approximately 1,000 manatees inhabit Florida waters (Telander 1980) along the Atlantic and gulf coasts. They sometimes appear seasonally in Georgia and rarely in South Carolina. On the gulf coast of Florida, manatees number 350 to 400 individuals. Distribution is continuous from Whitewater Bay to Charlotte Harbor. Further north, semi-isolated populations occur in Hillsborough, Citrus, and Levy Counties. Greatest abundance on the gulf coast occurs from Charlotte Harbor through the Ten Thousand Islands. From the period 1971-1973, manatees were reported in Hillsborough County in coastal areas, Hillsborough Bay, and the Little Manatee, Alafia, and Hillsborough Rivers. Winter congregations have been reported from the Big Bend generating plant (Hartman 1974). They are considered relatively common along the eastern shore of Tampa Bay where the population is estimated at 30 individuals. The U.S. Department of the Interior (44 FR 12, 3,636-3,654) has listed the Little Manatee River below Route 301 and the Alafia River from the U.S. Highway 41 bridge west 1 mile to its confluence with Tampa Bay as critical habitat for manatees in Hillsborough County. Primary factors for population decrease are mortality and injury due to power boat propellers, vandalism, poaching, and habitat destruction.

The manatee's primary habitats are sluggish rivers, shallow estuaries, and saltwater bays. Populations can be concentrated in estuarine and riverine habitats, especially spring-fed rivers. Primary habitats include areas with vascular aquatic vegetation, proximity to channels at least 2 meters deep, warm water during cold winter periods, and a source of fresh water. They are known to seek out the warm water of power-plant discharges in the winter.

Heated discharges and springs are important to manatees only during protracted periods of freezing or near-freezing temperatures (Hartman 1979). Although uncommon, these cold periods can occur in Florida from November through March. Thermal stress due to sudden cold periods in early winter may kill manatees if they have not yet acclimated themselves to colder water temperatures.

Manatees are well adapted to temperatures as low as 21°C; however, they can tolerate temperatures as low as 13.5°C with no apparent ill effects (Hartman 1979). When water temperatures drop below 21°C, manatees may seek out warmer water such as springs or warm-water discharges. Manatees do not usually begin to congregate in those warm-water areas until the air temperature drops to 10°C or below. This is especially true during the early part of the winter. Later in the winter, they usually do not congregate in warm water until the air temperature is 5°C or lower (Hartman 1979).

At the warm-water discharge of the Cities Service phosphate plant on the Alafia River near Gibsonton in Hillsborough County, manatees were found in water between 15.8°C and 19.0°C, even though the discharge water was 35.5°C (Hartman 1974).

The Applicant sponsored a study of the manatee in Tampa Bay and in the vicinity of the site between November 1979 and February 1980 (Patton 1980). The purpose of the study was to document the use of the Big Bend warm-water discharge canal by manatees and to determine the significance of the site as a winter refuge compared to other refuges available in the area. Regular observations were made by plane, by boat, and also from the shore (including the superstructure of the existing Big Bend units). Manatee sightings were most common in the mouth of the Manatee River during the warmer months and in the warm-water refuges during colder months. The highest manatee count during a single aerial survey was 55.

The Big Bend Power Station ranked second in importance as a warm-water refuge to the Gardinier Phosphate Plant on the Alafia River. As many as 10 manatees were observed in the Big Bend discharge canal during a single survey, while up to 42 individuals were sighted at the phosphate plant during an overflight in February. The eastern end of the Big Bend discharge canal (except for the boat ramp area) appeared to be the region most regularly used by the manatees. The distribution of the animals within the canal did not appear to be correlated with specific water temperature levels.

Use of the area by manatees may increase due to increased thermal discharges as a result of operaton of Big Bend Unit 4. Manatees could occur in the area during critical temperature drops in early winter, usually when the air temperature drops below

10°C and water temperatures in the thermal plume range from 16.0°C to 20.0°C. They are not expected to remain in the area the entire winter, but will migrate to other nearby areas within Tampa Bay when the air and water temperatures increase. Their occurrence will also depend on food availability in the discharge area.

Manatees feed primarily on submerged vascular aquatic vegetation. The dominant foods in saltwater bays include *Syringodium filiforme*, *Thalassia testudinum*, *Halodule* (*Diplanthera*) *wrightii*; and *Ruppia maritima*, *Thalassia*, and *Syringodium* are offshore forms that usually occur in waters of high salinity. *Halodule* and *Ruppia* are inshore species occurring under somewhat less saline conditions. Optimum feeding conditions are usually in water 1.0-1.6 meters deep. The frequency of occurrence of manatees near the Big Bend site would depend on food availability as well as water temperature.

5.3.4.6.2 Cetaceans

Twenty-one species of cetaceans have geographic ranges that could include Tampa Bay or adjacent waters of the Gulf of Mexico (Table 5-108). Only the bottle-nosed dolphin, *Tursiops truncatus*, is expected to occur in the area with any regularity. This species, as well as all cetaceans, are protected by the Marine Mammal Protection Act of 1972 (16 U.S.C. 1361). During the aerial survey program of Tampa Bay sponsored by the Applicant and conducted from June 1979 to February 1980, a total of 66 dolphin herd sightings representing 140 individuals were reported (Patton 1980).

Table 5-39. Extreme tides and high-water marks at Tampa, Florida[a]

Event	Tide height (ft msl)
High tides	
September 1848	14
October 1848	9
September 1919	5+
October 1921	9.6
September 1926	3.6
September 1929	3.1
September 1935	4.4
November 1935	4 to 5
October 1946	3.3
August 1949	3.9
September 1950	5.6
October 1950	2.5
September 1960	2.8
August 1964	1 to 3
June 1966	3 to 5
October 1968	4 to 6
June 1972	3 to 5
Low tides	
October 1910	-7.5
September 1926	-6.9
September 1935	-5.7
September 1947	-5.8

[a] From U.S. Army Corps of Engineers (1974).

Table 5-40. Jackson Branch and Newman Branch water-quality data[a,b]

Parameter	Collection locations 1[c]	2[d]	3[e]	4[f]	5[g]	6[h]
pH	7.6	7.6	8.5	7.9	7.6	8.5
Turbidity (Jackson units)	<25	<25	<25	<25	<25	<25
Conductivity (mmhos/cm)	1,100	7,500	16,400	10,900	3,100	15,500
Total solids	1,064	5,877	29,231	17,095	3,011	27,783
Volatile total solids	38	794	5,654	2,725	476	4,591
Fixed total solids	1,026	5,083	23,577	14,370	2,535	23,192
Total suspended solids	9	16	48	14	4	47
Volatile suspended solids	7	6	10	7	0	8
Fixed suspended solids	2	10	38	7	4	39
Ammonia as N	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Kjeldahl N	<1.0	2.68	<1.0	1.0	1.45	<1.0
Nitrate as N	0.10	0.10	0.11	0.07	0.19	0.08
Total phosphate as P	3.29	2.12	0.75	0.97	1.07	0.78
Biological oxygen demand (3-day)	3.7	3.9	2.0	5.8	3.2	1.4
Chemical oxygen demand	75.6	(i)	(i)	(i)	(i)	(i)
Oil and grease	<2	<2	2.2	<2	<2	<2
Orthophosphate	3.18	1.84	0.2	0.22	0.78	0.15
Chloride	72.5	2,407	13,146	8,281	1,123	12,318
Fluoride	1.25	0.97	1.15	0.98	0.54	1.18
Sulfates	430.8	822.2	2,048	1,330	397.5	2,285
Aluminum	0.12	0.20	0.42	0.46	0.39	0.27
Barium	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	171.9	204.2	310.4	159.2	100	201.7
Chromium	0.16	0.14	0.15	0.2	0.16	0.18
Copper	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Iron	0.53	0.38	0.05	0.03	0.86	0.03
Lead	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Magnesium	56.9	208.3	858	550	101.4	850
Mercury	<0.0002	0.0005	<0.0002	<0.0002	<0.0002	<0.0002
Nickel	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	0.05	0.06	0.05	0.05	0.05	0.04

[a] From Tampa Electric Company (1980c).

[b] All units in mg/ℓ unless otherwise noted.

[c] 1 = Jackson Branch 100 yards east of transmission lines.

[d] 2 = Jackson Branch at Big Bend Road bridge.

[e] 3 = Discharge channel east of Unit 3 discharge.

[f] 4 = Canal embayment at trailer park.

[g] 5 = Newman Branch at Beach Road bridge.

[h] 6 = Apollo Beach north embayment.

[i] Could not be determined because of high salinity.

Table 5-41. Water-quality data for Hillsborough Bay, Florida[a,b,c] (Sheet 1 of 2)

Parameter	Annual average ambient concentration 1972[d]	1978[e]	1979[f]	Florida Class III water standard[g]	Average composition of seawater[h]
Alkalinity, total	102.4				
Biochemical oxygen demand	1.8	3.1	2.9		
Calcium	335				413
Chloride	15,880				19,353
Chromium (total)	<0.01			≤0.05[i]	
Color (platinum color units)	8.5	13.3	17.1		
Conductivity (mhos/cm)	37,510	39,535	39,258		
Copper	<0.01			≤0.015	≤0.002
Effective light penetration (in.)	61.7	32.4	32.2		
Fluoride	2.4	2.4		≤5.0	1
Hardness	4,494				
Iron, total	0.01			≤0.3	≤0.001
Lead, dissolved	≤0.01			≤0.05	
Magnesium	967				1,294
Nitrogen					
Total Kjeldahl	0.40	0.13	0.06		0.02
Total nitrate	0.05	0.02	0.03		
Ammonia	0.01	0.03	0.04		
Oxygen, dissolved	6.37	7.2	7.0	≥4.0	
pH (standard units)	8.02			6.5–8.5	8.1
Phosphorus, dissolved orthophosphate	1.89	1.22	1.01		0.073
Potassium, dissolved	272.6				387
Salinity (parts per thousand)	28.9	24.9	24.7		10,760
Sodium, dissolved	8,382				
Solids, suspended	13.2	42.6	61.0		2,712
Sulfate (as SO_4)	2,098				
Sulfide	0.03				

Note: See abbreviations and footnotes at end of table.

Table 5-41. Water-quality data for Hillsborough Bay, Florida[a,b,c] (Sheet 2 of 2)

Parameter	Annual average ambient concentration			Florida Class III water standard[g]	Average composition of seawater[h]
	1972[d]	1978[e]	1979[f]		
Turbidity (Jackson units)	4.7	5.9	4.6	50	
Water temperature (°C)	24.0	22.4	24.1		
Zinc	≤0.01			≤1.0	<0.05

[a] Adapted from Tampa Electric Company (1980b).

[b] Average value from four HCEPC sampling stations (Nos. 9, 73, 80, 81) in Hillsborough Bay near the Big Bend Station.

[c] Values in mg/ℓ unless otherwise indicated.

[d] Hillsborough County Environmental Protection Commission (1973).

[e] Hillsborough County Environmental Protection Commission (1979b).

[f] Hillsborough County Environmental Protection Commission (1980).

[g] Applicable to most of Hillsborough Bay.

[h] Martin (1970).

[i] After reasonable mixing of discharge in receiving water.

Table 5-42. Intake cooling-water quality at Big Bend Station[a,b]

Parameter	Minimum	Average	Maximum
pH[c,d,e]	7.3	--	8.5
Alkalinity, as $CaCO_3$[c]	102	154.2	300
Total solids[c]	23,550	25,199	26,580
Total suspended solids[f]	16.3	24.2	44.3
Nitrogen, nitrate as N[c]	<0.05	0.05	0.05
Phosphorus, total as P[c]	0.9	2.5	3.3
Sulfate, as SO_4[d,e]	1,850	1,892	1,965
Phosphate[f]	0.667	0.768	0.922
Organic phosphorus[f]	0.005	0.169	0.206
Ammonia[f]	0.04	0.07	0.08
Nitrite, NO_2[f]	0.005	0.005	0.006
Nitrate, NO_3[f]	0.005	0.023	0.046
Bromide[d]	0.71	1.52	2.98
Chloride[c,d]	8,326	12,774	19,813
Fluoride[c,d,e]	1.2	2.0	5.3
Aluminum[d]	<0.10	0.22	0.38
Antimony[d]	<0.2	0.5	0.8
Arsenic[d]	0.124	0.204	0.293
Beryllium[d]	<0.005	0.012	0.019
Cadmium[f]	0.001	0.001	0.001
Calcium[d]	116	276	330
Chromium[f]	0.006	0.022	0.045
Copper[f]	0.004	0.008	0.013
Iron[f]	0.01	0.05	0.08
Lead[f]	0.01	0.01	0.01
Magnesium[c,d]	122	407	905
Manganese[f]	0.01	0.02	0.04
Mercury[f]	0.0001	0.0001	0.0002
Nickel[f]	0.004	0.005	0.01
Selenium[d]	0.129	0.281	0.565
Potassium[c,d]	204	278	301
Sodium[c,d]	4,550	7,150	7,600
Thallium[d]	<0.1	0.15	0.2
Zinc[f]	0.007	0.008	0.011
Oil and grease[f]	<1.0	1.5	1.9

[a] From Tampa Electric Company (1981b).

[b] All except pH data in milligrams per liter.

[c] Water quality data for period April 29, 1973, through May 5, 1973, Stone & Webster Engineering Corporation.

[d] Water quality data for period October 15, 1979, through December 3, 1979, Tampa Electric Company Central Testing Laboratory.

[e] Water quality data for June 26, 1979, Thorton Laboratories, Inc.

[f] 316 Demonstration - BB4, Fine Mesh Screen Study Report, Tampa Electric Company, November 1980, Station 1.

Table 5-43. Summary of water-quality data for the Floridan aquifer[a]

Parameter	Number of wells	Maximum	Minimum	Median
Chloride	90	3,300 mg/ℓ	1 mg/ℓ	20 mg/ℓ
Sulfate	87	990 mg/ℓ	0 mg/ℓ	235 mg/ℓ
Hardness (Ca, Mg)	52	2,100 mg/ℓ	150 mg/ℓ	450 mg/ℓ
Specific conductance	87	10,900 μmhos	220 μmhos	840 μmhos
Total dissolved solids[b]	87	8,500 mg/ℓ	190 mg/ℓ	605 mg/ℓ

[a] From Dames and Moore (1975).

[b] Total dissolved solids as a function of conductivity.

Table 5-44. Water quality of site ground water and suggested EPA standards[a,b]

Parameter	Surficial aquifer at site, March 1976[c] West well	East well	South well	North well	Floridan aquifer[d] 1953	1974	EPA standards[e]
Phosphate, total	4.13	3.15	3.6	3.43			
Silica	47.9	45.4	14.8	44.2	21	28	
Calcium	692	155	176	1116	170	170	
Magnesium	173	51	53	384	65	52	
Sodium	10,000	18	17	300		50	
Potassium	1.9	0.5	1.6	1.4		3.1	
Iron, total	1.46	0.64	0.66	0.81	0.28	0.10	
Iron, dissolved	0.2	0.14	0.40	0.36			
Nickel	0.0	0.0	0.0	0.0			
Copper	0.01	0.01	0.01	0.01			1.0
Cadmium[f]	0.01		0.1	<0.01			0.01
Chromium	6.6	9.9	5.0	7.9			0.05
Lead[f]	<0.05		<0.05	<0.05			0.05
Mercury[f]	<0.002		<0.002	<0.002			
Selenium[f]	<0.5		<0.5	<0.5			0.01
Zinc	0.45	0.25	0.17	0.68			6.0
Manganese	0.12	0.18	0.18	0.24			0.05
Vanadium[f]	<1		<1	<1			
Sulfate	93.2	102.8	82.7	180.7	510	450	250
Chloride	2570	35	59	3317	88	100	250
Bicarbonate					172	173	
Nitrogen	0.56	0.89	0.22	0.78			
Nitrates	2.6	4.6	2.2	3.75			45
Arsenic[f]	0.28		0.05	0.06			
Bromine	8.6	0.1	0	12.5			
Phosphorus	0.04	0.22	0.2	0.08	0.4	0.6	
Biological oxygen demand	0	0	0	0			
Total dissolved solids	3641	4789	627	4329	1080	1000	500
Total suspended solids	50	35	14	59			
pH	7.00	6.96	8.35	6.4	7.3	7.3	
Oil and grease	0	0	0	0			
Turbidity (Ftu)	28	24	32	40			

[a] From Tampa Electric Company (1980b).

[b] All data in parts per million unless otherwise indicated.

[c] Environmental Associates, Inc., analyses dated March 10, 1976.

[d] Duerr (1979).

[e] EPA standards for drinking water, primary and secondary.

[f] Interscience Associates, Inc., analyses dated December 15, 1975.

Table 5-45. Phytoplankton taxa reported from collections made at Big Bend from June 1972 to May 1974[a] (Sheet 1 of 3)

Diatoms

Achnanthes spp.
Achnanthes longipes
Actinocyclus spp.
Actinocyclus octonarius
Actinoptychus spp.
Actinoptychus splendens
Actinoptychus undulatus
Amphiprora spp.
Amphiprora gigantea v. *sulcata*
Amphora spp.
Amphora marina
Amphora obtusa
Amphora spectabilis
Amphora A
Anomoeneis sculpta
Asterionella sp.
Asterionella japonica
Asteromphalus flabellatus
Aulacodiscus sp.
Aulacodiscus argus
Auliscus sp.
Auliscus punctatus
Auliscus pruinosus
Auliscus sculptus
Bacteriastrum sp.
Bacteriastrum comosum
Bellerochea malleus
Biddulphia spp.
Biddulphia alternans
Biddulphia aurita
Biddulphia aurita v. *obtusa*
Biddulphia dubia
Biddulphia mobiliensis
Biddulphia obtusa
Biddulphia pulchella
Biddulphia regia
Biddulphia reticulum
Biddulphia rhombus
Biddulphia rhombus f. *trigona*
Caloneis westii
Campylodiscus echeneis
Centric diatoms
Cerataulina bergonii
Cerataulina pelagica
Chaetoceros spp.
Chaetoceros affinis
Chaetoceros compressus
Chaetoceros curvisetus
Chaetoceros danicum
Chaetoceros didymus
Chaetoceros diversus
Chaetoceros eibenii
Chaetoceros laciniosum
Chaetoceros lauderi
Chaetoceros lorenzianum
Chaetoceros pendulus
Chaetoceros peruvianum
Chaetoceros simplex/gracilis
Chaetoceros socialis
Chaetoceros subtilis
Chaetoceros teres
Chaetoceros wighami
Chaetoceros A
Chaetoceros B
Chaetoceros C
Chaetoceros D
Chain form A
Chain form B
Climacodium frauenfeldianum
Climacosphena moilgera
Cocconeis spp.
Cocconeis disculoides
Cocconeis heteroidea
Cocconeis A
Corethron criophyllum
Coscinodiscus spp.
Coscinodiscus centralis
Coscinodiscus concinnus
Coscinodiscus eccentricus
Coscinodiscus eccentricus f. *fasciculata*
Coscinodiscus granii
Coscinodiscus lineatus
Coscinodiscus marginatus
Cyclotella spp.
Dacylioslen sp.
Diploneis spp.
Diploneis crabo
Diploneis gruendleri
Diploneis obliqua

Note: See footnote at end of table.

Table 5-45. Phytoplankton taxa reported from collections made at Big Bend from June 1972 to May 1974[a] (Sheet 2 of 3)

Diatoms (continued)

Diploneis A
Diploneis B
Donkinia recta
Epithemia spp.
Eunotogramma spp.
Eunotogramma marinum
Eupodiscus radiatus
Grammatophora ssp.
Grammatophora marina
Guinardia spp.
Guinardia flaccida
Gyrosigma spp.
Gyrosigma balticum
Gyrosigma fasciola
Gyrosigma hummii
Gyrosigma wansheckii
Hantzschia ssp.
Hantzschia virgata
Hemialus hauckii
Hemialus membranaceus
Hemialus sinensis
Hemidiscus hardmanianus
Lauderia borealis
Leptocylindrus danicus
Leptocylindrus minimus
Licmophora spp.
Lithodesmium spp.
Lithodesmium undulatum
Mastoglia spp.
Mastoglia binotata
Mastoglia cribrosa
Melosira spp.
Melosira granulata
Melosira nummuloides
Melosira A
Naviculoid spp.
Naviculoid A
Naviculoid B
Naviculoid C
Naviculoid D
Navicula spp.
Navicula cancellata
Navicula clavata
Navicula forcipata
Navicula lyra
Navicula marina
Navicula nummularia
Navicula pygmaea
Navicula wanrikae
Navicula A
Nitzschia spp.
Nitzschia closterium
Nitzschia constricta
Nitzschia delicatissima
Nitzschia longissima
Nitzschia parodoxa
Nitzschia pugens v. *atlanticum*
Nitzschia A
Nitzschia B
Paralia sulcata
Paralia sulcata f. *coronata*
Paralia A
Pinnularia sp.
Pinnularia rectangulata
Plagiogramma ssp.
Plagiogramma staurophorum
Plagiogramma A
Pleurosigma ssp.
Pleurosigma angulatum
Pleurosigma rostratum
Pleurosigma strigosum
Pleurosigma A
Podosira stelliger
Podosira A
Rhardonema sp.
Rhardonema adriaticum
Rhizosolenia alata
Rhizosolenia calcar-avis
Rhizosolenia fragilissima
Rhizosolenia robusta
Rhizosolenia setigera
Rhizosolenia stolterfothii
Rhizosolenia styliformis
Skeletonema spp.
Skeletonema costatum
Skeletonema tropicum
Streptotheca temesis
Striatella unipunctata
Striatella interrupta
Surirella spp.

Note: See footnote at end of table.

Table 5-45. Phytoplankton taxa reported from collections made at Big Bend from June 1972 to May 1974[a] (Sheet 3 of 3)

Diatoms (continued)

Surirella fatuosa v. *recedens*
Surirella gemma
Surirella ovata
Synedra spp.
Synedra crystallina
Synedra fennedyana
Synedra A
Thalassionema sp.
Thalassionema nitzschioides
Thalassiosira sp.
Thalassiosira aestivalis
Thalassiosira decipiens
Thalassiosira subtilis
Thalassiosira A
Thalassiothrix sp.
Thalassiothrix frauenfeldii
Thalassiothrix mediterranea f. *pacifica*
Thalassiothrix A
Trachyneis sp.
Trachyneis aspera
Triceratium favus
Tropidoneis lepidoptera
Unidentified Fragilariaceae

Dinoflagellates

Amphidinium spp.
Ceratium fusus
Ceratium hircus
Ceratium trichoeros
Ceratium tripos
Cochlodinium spp.
Dinophysis sp.
Dinophysis caudata f. *acutiformis*
Diplopsalis lenticula
Diplopsalis rotunda
Exuviaella spp.
Exuviaella mariae-lebouriae
Exuviaella oblonga
Gonyaulax spp.
Gonyaulax balechii
Gonyaulax diacantha
Gonyaulax diegenesis
Gonyaulax digitalis
Gonyaulax monilata
Gonyaulax polygramma
Gonyaulax scrippsae
Gonyaulax spinifera
Gonyaulax A
Gymnodinium/Glenodinium spp.
Gymnodinium breve
Gymnodinium splendens
Gyrodinium spp.
Gyrodinium fissum
Gyrodinium spirale
Massartia glauca
Peridinium spp.
Peridinium claudicans
Peridinium conicum
Peridinium deficiens
Peridinium depressum
Peridinium diacantha
Peridinium divergens
Peridinium excentricum
Peridinium leonis
Peridinium nipponicum
Peridinium oblongum
Peridinium pellucidum
Peridinium pentagonum
Peridinium quinquecorne
Peridinium subinerne
Peridinium A
Polykrikos hartmannii
Polykrikos kofoidi
Polykrikos schwartzi
Prorocentrum sp.
Prorocentrum gracile
Prorocentrum maximum
Prorocentrum micans
Prorocentrum minimum
Pyrodinium bahamense
Pyrophacus horologicum
Pyrophacus steinii
Pyrophacus vancampoae
Torodinium robustum
Microflagellates

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[a] Adapted from Tampa Electric Company (1975a).

Table 5-46. Phytoplankton taxa (in order of decreasing abundance) reported from collections made at Big Bend from January 1976 to March 1977[a] (Sheet 1 of 2)

Skeletonema costatum
Oscillatoria sp.
Hemiaulus sinensis
Rhizosolenia delicatula
Ceratium hircus
Asterionella japonica
Gonyaulax polygrama
Rhizosolenia setigera
Vegetative cell (dinoflagellate)
Chaetoceros spp.
Nitzschia delicatissima
Nitzschia pungens v. *atlanticum*
Cerataulina pelagica
Leptocylindrus danicus
Peridinium pellucidum
Nitzschia closterium
Thalassionema nitzschioides
Licmophora sp. A
Prorocentrum minimum
Gonyaulax digitalis
Dinophysis caudata f. *acutiformis*
Skeletonema tropicum
Coscinodiscus spp.
Thalassiosira aestivalis
Gonyaulax monilata
Coscinodiscus eccentricus
Unidentified blue-green alga
Gonyaulax diacantha
Peridinium divergens
Ceratium fusus
Dissodium lenticula
Prorocentrum micans
Guinardia flaccida
Unknown green alga
Corethron criophilum
Hemiaulus sp.
Coscinodiscus sp.
Unknown centric diatom
Anabaena
Thalassiosira decipiens
Peridinium claudicans
Gymnodinium splendens
Peridinium sp.
Bacillaria paradoxa
Coscinodiscus marginatus
Gymnodinium sp.
Navicula spp.
Peridinium spp.
Peridinium leonis
Rhizosolenia calcar-avis
Coscinodiscus granii
Chaetoceros danicum
Lithodesmium undulatum
Gyrosigma/Pleurosigma B
Coscinodiscus centralis
Oxytoxum scolopax
Bellerochea malleus
Amphora marina
Ceratium furca
Peridinium depressum
Melosira nummuloides
Melosira sp.
Peridinium sp. A
Chaetoceros simplex
Peridinium oblongum
Chaetoceros sp.
Pyrophacus steinii
Peridinium pentagonum
Gonyaulax sp.
Peridinium subinerme
Striatella unipunctata
Streptotheca tamesis
Gyrodinium sp.
Tropidoneis sp.
Grammatophora marina
Rhizosolenia sp.
Massartia glauca
Fragilidium sp.
Tropidoneis lepidoptera
Coscinodiscus radiatus
Navicula sp.
Euglena sp.
Biddulphia alternans
Achnanthes longipes
Gyrodinium spp.
Nitzschia sp.
Biddulphia sinensis
Polykrikos hartmannii
Navicula wawrikae
Oscillatoria spp.
Amphiprora gigante v. *sulcata*
Amphora sp.
Fragilidium sp. A
Rhizosolenia alata

Note: See footnote at end of table.

Table 5-46. Phytoplankton taxa (in order of decreasing abundance) reported from collections made at Big Bend from January 1976 to March 1977[a] (Sheet 2 of 2)

Gyrosigma/Pleurosigma A
Polykrikos schwartzi
Merismopedia sp.
Gymnodinium spp.
Biddulphia sp.
Actinoptychus senarius
Peridinium quinquecorne
Biddulphia aurita
Unknown diatom
Biddulphia mobiliensis
Amphora spectabilis
Fragilidium spp.
Unknown penate
Thalassionema sp.
Polykrikos sp.
Auliscus sp.
Triceratium favus
Biddulphia rhombus
Rhizosolenia stolterfothii
Rhizosolenia styliformis
Navicula lyra
Pyrophacus sp.
Auliscus sculptus
Scenedesmus quadricauda
Gyrodinium spirale
Synedra sp.
Mastoglia sp.
Gyrosigma/Pleurosigma C
Diploneis crabo
Bacillaria sp.
Actinoptychus sp.
Gyrodinium fissum
Podosira stelliger
Hantzschia virgata
Biddulphia dubia
Actinoptvchus undulatus
Actinoptychus splendens
Actinocyclus sp.

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[a]Adapted from Hughes and Parks (1977).

Table 5-47. The 20 most abundant phytoplankton taxa (in order of decreasing abundance) reported from collections made at Big Bend from January 1976 to March 1977[a]

- *Skeletonema costatum* (diatom)
- *Oscillatoria* sp. (blue-green alga)
- *Hemiaulus sinensis* (diatom)
- *Rhizosolenia delicatula* (diatom)
- *Ceratium hircus* (dinoflagellate)
- *Asterionella japonica* (diatom)
- *Gonyaulax polygrama* (dinoflagellate)
- *Rhizosolenia setigera* (diatom)
- *Nitzschia delicatissima* (diatom)
- *Nitzschia pungens* v. *atlanticum* (diatom)
- *Cerataulina pelagica* (diatom)
- *Leptocylindrus danicus* (diatom)
- *Periodinium pellucidum* (dinoflagellate)
- *Nitzschia closterium* (diatom)
- *Thalassionema nitzschioides* (diatom)
- *Licmophora* sp. (diatom)
- *Prorocentrum minimum* (dinoflagellate)
- *Gonyaulax digitalis* (dinoflagellate)
- *Dinophysis caudata* f. *acutiformis* (dinoflagellate)

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[a]Adapted from Hughes and Parks (1977).

Table 5-48. Benthic algae reported from collections made in Hillsborough Bay during 1958[a]

Category	Taxon
Cyanophyta	*Anacystis aeruginosa*
	Mastigocoleus testarum
Chlorophyta	*Cladophora fascicularis*
	Enteromorpha salina
	Ulva fasciata
	Ulva lactuca
Phaeophyta	*Ectocarpus siliculosus*
Rhodophyta	*Agardhiella tenera*
	Champia parvula
	Gracilaria verrucosa
	Hypnea musciformis
	Polysiphonia denudata
	Spyridia filamentosa

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[a]Adapted from Phillips (1960).

Table 5-49. Benthic algae reported from collections made at Big Bend from 1970 to 1973[a]

Cyanophyta
Hormothamnion sp.
Oscillatoria sp.
Spirulina sp.
Chlorophyta
Caulerpa prolifera
Chaetomorpha sp.
Cladophora gracilis (?)
Enteromorpha intestinalis
Rhizoclonium sp.
Ulva lactuca
Rhodophyta
Acanthophora specifera
Agardhiella tenera
Centroceras clavulatum
Ceramium fastigiatum
Ceramium sp.
Champia parvula
Chondria sedifolia
Chondria sp.
Gracilaria blodgettii
Gracilaria compressa
Gracilaria debilis (?)
Gracilaria verrucosa
Gracilaria sp.
Gelidium sp.
Hypnea cervicornis
Hypnea cornuta
Hypnea musciformis
Hypnea spinella
Lomentaria bailyana
Polysiphonia denudata
Spyridia filamentosa

[a]Adapted from Tampa Electric Company (1973).

Table 5-50. Benthic marine algal and seagrass taxa reported from collections made at three sites in the embayment near the Big Bend Powerplant during 1975[a]

Taxon	Location of collection		
	Site I	Site II	Site III
Algae			
Chaetomorpha sp.	L	--	--
Cladophora sp.	L	L, SBL	SBL
Cladophoropsis sp.	L	L	L, SBL
Enteromorpha sp.	L, SBL	SBL	SBL
Ulva lactuca	L	L	L, SBL
Hypnea sp.	--	SBL	SBL
Laurencia sp.	--	SBL	SBL
Seagrass			
Halodule wrightii	SBL	SBL	SBL

Abbreviations:
L = littoral.
SBL = sublittoral.

[a]Adapted from Tampa Electric Company (1975b).

Table 5-51. Distribution and abundance of benthic seagrasses during surveys conducted at transects located in a control area and in areas near the Big Bend Powerplant during quarterly sampling in 1977 and 1978[a]

Transect	Sampling period							
	1977				1978			
	Mar.	June	Sept.	Dec.	Mar.	June	Sept.	Dec.
Control (116 quadrats)								
Ruppia maritima								
VQ	26	32	25	12	26	26	16	0
DEN	300	2,500	1,500	1,300	2,685	1,850	1,500	0
Halodule wrightii								
VQ	2	4	10	17	2	5	10	17
DEN	320	2,600	1,300	1,400	1,450	2,100	3,460	3,000
Syringodium filiforme								
VQ	2	2	2	2	2	2	2	2
DEN	1,950	2,000	1,970	1,920	2,175	2,600	2,225	2,120
Thalassia testudinum								
VQ	0	0	0	2	1	1	1	1
DEN	0	0	0	60	600	700	650	600
B-1 (22 quadrats)								
Halodule wrightii								
VQ	0	1	0	0	0	0	1	0
DEN	0	2,400	0	0	0	0	1,750	0
A-1 (17 quadrats)								
Ruppia maritima								
VQ	14	10	0	0	10	5	0	0
DEN	950	920	0	0	1,780	610	0	0
A-2 (37 quadrats)								
Ruppia maritima								
VQ	10	8	0	0	8	2	0	0
DEN	1,100	9,600	0	0	450	375	0	0
A-3 (37 quadrats)								
Ruppia maritima								
VQ	1	1	0	0	1	1	0	0
DEN	300	100	0	0	200	300	0	0

Abbreviations:

VQ = number of vegetated quadrats.

DEN = average density of seagrasses per m^2.

[a] Adapted from Mangrove Systems, Inc. (1979).

Table 5-52. Zooplankton taxa reported from collections made at Big Bend from 1970 to 1975[a] (Sheet 1 of 3)

Protozoa

Dictyocha fibula
Coccolithophora sp.
Unidentified Cryptomonaidida
Ebria sp.
Euglena mutabilis
Trachelocera sp.
Unidentified Euglenida
Amoeba sp.
Unidentified Foraminifera
Unidentified Radiolaria
Unidentified Heliozoia
Lacrymaria oloa
Carchesium sp.
Vorticella spp.
Stentor sp.
Condonella sp.
Coxtella sp.
Eutintinnus sp.
Favella sp.
Helicostomella sp.
Salpingella sp.
Stentosemella sp.
Tintinniopsis spp.
Unidentified Hypotrichida

Cnidaria

Unidentified Hydrozoa fragments
Unidentified Anthomedusae
Obelia sp.
Unidentified Leptomedusa
Unidentified Actinulida larvae
Unidentified Actinaria
Ephyra larvae
Pleurobrachia sp.
Mnemiopsis sp.
Beroe sp.

Platyhelminthes

Muller's larvae
Unidentified Turbellaria

Rhynchocoela

Pilidium larvae

Rotifera

Synchaeta sp.
Trichocera sp.
Unidentified Rotifera

Gastrotricha

Heterolipidoderma sp.
Unidentified Gastrotricha

Nematoda

Unidentified Nematoda

Annelida

Unidentified Polychaeta larvae
Unidentified Polychaeta trochophores
Unidentified Spionidae
Chaetopterus sp.

Note: See footnote at end of table.

Table 5-52. Zooplankton taxa reported from collections made at Big Bend from 1970 to 1975[a] (Sheet 2 of 3)

Annelida (continued)

Unidentified Neridae larvae
Unidentified Nephthidae
Unidentified Capitellidae
Unidentified Hirudinea

Mollusca

Unidentified Gastropoda veligers
Unidentified Bivalvia veligers

Arthropoda

Halacardiae
Unidentified Ostracoda
Evadne spp.
Podon sp.
Penilia avirostris
Unidentified Calanoida
Unidentified Pontellidae nauplii
Unidentified Mysida
Unidentified Cumacea
Unidentified Isopoda
Unidentified Caprellidea
Unidentified Amphipoda
Unidentified Penaeidea larvae
Unidentified Caridea larvae
Unidentified Harpacticoida
Unidentified Cyclopoida
Saphirella spp.
Unidentified Copepoda nauplii
Unidentified Cirripedia nauplii
Unidentified Cirripedia cypris
Lucifer shrimp
Porcellanidae zoea
Pinnixa sp.
Unidentified Euphausiacea
Unidentified Decapoda
Crab zoea

Phoronida

Actinotroch larvae

Bryozoa

Bryozoan fragments
Ectoproct fragments
Cyphonautes larvae

Brachiopoda

Brachiopoda larvae

Echinodermata

Echinodermata larvae
Auricularia larvae
Unidentified Holothuroidea

Hemichordata

Tornaria larvae

Note: See footnote at end of table.

Table 5-52. Zooplankton taxa reported from collections made at Big Bend from 1970 to 1975[a] (Sheet 3 of 3)

Chordata	
Ascidiacea larvae	*Branchiostoma floridae*
Oikopleura sp.	
Chaetognatha	
Chaetognatha	Chaetognatha larvae
Chaetognatha eggs	

[a] Adapted from Tampa Electric Company (1975a).

Table 5-53. Relative abundance of ichthyoplankton taxa reported from collections made at Big Bend from January 1976 to March 1977[a]

Eggs		Larvae	
Family	Percent of total	Family	Percent of total
Engraulidae	73.1	Engraulidae	87.4
Sciaenidae	26.2	Sciaenidae	3.9
Carangidae	0.4	Gobiidae	2.7
Clupeidae	0.2	Pomadasyidae	2.1
Soleidae	0.1 (total)	Carangidae	1.1
Triglidae		Sparidae	1.1
Pomadasyidae		Clupiedae	0.5
Ephippidae		Blenniidae	0.4
Belonidae		Soleidae	0.2
Atherinidae		Triglidae	0.2
Gobiidae		Atherinidae	0.1
		Gobiesocidae	0.3 (total)
		Syngnathidae	
		Cynoglossidae	
		Ephippidae	
		Ophicthidae	
		Tetraodontidae	
		Mugilidae	
		Belonidae	
		Bothidae	
		Cyprinodontidae	
		Gerreidae	

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[a] Adapted from Phillips et al. (1977).

Table 5-54. Relative abundance of invertebrate meroplankton taxa reported from collections made at Big Bend from January 1976 to March 1977[a] (Sheet 1 of 3)

Taxon	Percent of total
Pinnixa sayana	34.70
Polyonyx gibbesi	28.28
Upogebia affinis	10.77
Neopanope texana	4.43
Gastropoda[b]	2.97
Hexapanopeus angustifrons	2.52
Pinnixa chaetopterana	2.05
Balanus sp.[b]	1.70
Ambidexter symmetricus	1.22
Xanthidae (damaged)	1.18
Alpheidae sp. A	1.09
Periclimenes spp.	<1.00[c]
Eurypanopeus depressus	
Grapsizoea spp.[d]	
Uca spp.	
Menippe mercenaria	
Pinnotheres maculatus	
Persephona punctata	
Brachiopoda[b]	
Spionidae[b]	
Ogyrides limicola	
Echinodermata	
Pelecypoda	
Latreutes parvulus	
Panopeus herbstii	
Petrolisthes spp.	
Porcellanidae (damaged)	
Caridea (damaged)	
Hippolyte spp.	
Pagurus longicarpus	
Nereidae[b]	
Sesarma cinereum	
Decapoda (damaged)	
Paguridae sp. A	<0.10[e]
Alpheidae sp. C	
Sesarma reticulatum	
Alpheidae (damaged)	
Processa spp.	
Polychaeta[b]	
Rithropanopeus harrisii	
Palaemonetes intermedius	
Pinnotheridae (damaged)	
Palaemonidae (damaged)	
Libinia dubia	

Note: See footnotes at end of table.

Table 5-54. Relative abundance of invertebrate meroplankton taxa reported from collections made at Big Bend from January 1976 to March 1977[a] (Sheet 2 of 3)

Taxon	Percent of total
Squilla sp.	<0.10[e]
Palaemonetes spp.	
Urochordata	
Brachyura (unidentified)	
Hippolytidae (damaged)	
Neopanope packardii	
Leptochela sp.	
Alpheidae sp. B	
Megalops (unidentified)	
Periclimenes americanus (postlarvae)	
Palaemonetes pugio/vulgaris	
Palaemonidae sp. C	
Portunidae sp. A	
Alpheidae sp. D	
Palaemon floridanus	
Callianassa sp. A	
Tozeuma carolinense	
Polynoidae[b]	
Pinnixa sp. A	
Pagurus annulipes	<0.01[f]
Pinnotheres sp. A	
Brachyura sp. A	
Processidae (damaged)	
Callinectes sp. A	
Hippolytidae sp. D	
Callianassa sp. D	
Paguridae (damaged)	
Penaeus duorarum	
Euceramus praelongus	
Aegathoa	
Phoronida[b]	
Zoea (unidentified)	
Callianassa sp. C	
Paguridae sp. C	
Flabelligeridae[b]	
Pinnotheres sp. B	
Postlarvae (unidentified)	
Syllidae	
Brachyura sp. B	
Callianassa sp. B	
Leptochela serritorbita	
Leucosiidae (damaged)	
Hippolytidae sp. B	

Note: See footnotes at end of table.

Table 5-54. Relative abundance of invertebrate meroplankton taxa reported from collections made at Big Bend from January 1976 to March 1977[a] (Sheet 3 of 3)

Taxon	Percent of total
Branchiostoma caribaeum[b]	
Majidae (damaged)	
Palaemonidae sp. B	
Periclimenes longicaudatus (postlarvae)	
Grapsizoea sp. A[d]	
Limulus polyphemus[b]	
Portunidae (damaged)	<0.001[g]
Thor floridanus	
Grapsidae (damaged)	
Pinnixa sp. B	
Hippolytidae sp. A	
Hippolyte zostericola (postlarvae)	
Orbiniidae	
Alpheidae sp. E	
Pagurus pollicaris	
Alpheus sp. (postlarvae)	
Alpheus heterochaelis (postlarvae)	
Porcellana sayana	
Leander sp.	
Naushonia sp.	
Penaeidae (damaged)	
Callianassidae (damaged)	
Cirritulidae[b]	
Callinectes sapidus (postlarvae)	

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[a] Adapted from Blanchet, Avery, and Leverone (1977).

[b] Only qualitatively sampled.

[c] Value for each of the listed taxa from *Periclimenes* spp. through Decapoda (damaged).

[d] Unidentified organisms believed to include *Uca* spp. or *Sesarma* sp.

[e] Value for each of the listed taxa from Paguridae sp. A through *Pinnixa* sp. A.

[f] Value for each of the listed taxa from *Pagurus annulipes* through *Limulus polyphemus*.

[g] Value for each of the listed taxa from *Portunidae* (damaged) through *Callinectes sapidus* (postlarvae).

Table 5-55. Select representative important species (RIS) chosen for concentrated study during the aquatic ecology studies conducted at Big Bend during 1979-1980[a]

Scientific name	Common name
Invertebrates	
Crassostrea virginica	Eastern oyster
Penaeus duorarum	Pink shrimp
Callinectes sapidus	Blue crab
Menippe mercenaria	Stone crab
Fishes	
Harengula jaguana	Scaled sardine
Anchoa mitchilli	Bay anchovy
Menidia beryllina	Tidewater silverside
Bairdiella chrysoura	Silver perch
Cynoscion nebulosus	Spotted seatrout
Pogonias cromis	Black drum

[a] Adapted from Mahadevan (1980).

Table 5-56. Mean abundance of *Anchoa mitchilli* eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 1 of 2)

Sampling date	Developmental stage	Station A	B	C	D	E	Mean
2-27-79	E	175	156	140	312	35	164
	L	1	5	2	3	0	2
3-13-79	E	2,423	2,817	3,129	7,081	562	3,202
	L	168	74	101	332	5	136
3-27-79	E	2,424	1,910	14,599	9,899	7,603	7,287
	L	602	777	1,502	368	89	668
4-10-79	E	10,454	4,459	32,197	36,422	17,470	20,200
	L	1,353	946	980	1,731	94	1,021
4-26-79	E	1,202	842	19,701	12,357	11	6,823
	L	368	1,191	4,806	482	853	1,540
5-10-79	E	6,074	2,225	39,478	26,950	39	14,953
	L	2,033	5,727	2,886	1,145	765	2,511
5-25-79	E	18,478	24,022	33,585	13,870	2	17,991
	L	638	2,770	2,310	2,515	57	1,658
6-5-79	E	17,148	8,075	74,136	8,906	1	21,653
	L	1,395	2,702	730	454	14	1,059
6-19-79	E	12,484	12,804	2,859	7,806	510	7,293
	L	762	666	529	370	150	495
7-3-79	E	18,295	1,780	2,429	11,817	45	6,866
	L	6,615	6,059	4,190	4,239	259	4,272
7-17-79	E	13,358	3,500	654	10,633	45,355	14,700
	L	454	724	289	2,535	1,238	1,048
7-31-79	E	26,868	16,086	10	657	20,419	12,808
	L	94	175	109	79	1,425	376
8-14-79	E	1,297	1,509	2,739	3,891	12,706	4,428
	L	409	1,510	656	650	2,849	1,215
8-28-79	E	1,467	1,576	3,212	143	6,117	2,503
	L	64	616	978	288	225	434
9-14-79	E	175	95	2,100	230	3,358	1,192
	L	186	53	219	55	73	117
9-25-79	E	397	740	35	24	2,213	682
	L	106	158	180	15	123	116
10-9-79	E	≤0.5	2	27	1	76	21
	L	6	3	13	7	35	13
10-23-79	E	0	2	12	2	175	38
	L	1	18	12	15	53	20
11-6-79	E	0	0	1	0	1	4
	L	1	3	8	4	5	4
11-20-79	E	0	0	0	0	0	0
	L	≤0.5	2	≤0.5	1	2	1
12-4-79	E	0	0	0	0	0	0
	L	≤0.5	1	≤0.5	0	≤0.5	<1

Note: See abbreviations and footnote at end of table.

Table 5-56. Mean abundance of *Anchoa mitchilli* eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 2 of 2)

Sampling date	Developmental stage	Station A	B	C	D	E	Mean
12-18-79	E	0	0	0	0	0	0
	L	0	0	≤0.5	0	0	<1
1-2-80	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
1-17-80	E	≤0.5	0	0	0	0	<1
	L	0	0	0	0	0	0

Abbreviations:
E = eggs.
L = larvae.

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-57. Mean abundance of unidentified sciaenid eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 1 of 2)

Sampling date	Developmental stage	Station A	B	C	D	E	Mean
2-27-79	E	1	2	1	1	7	2
	L	0	0	0	0	0	0
3-13-79	E	7	14	2	2	23	10
	L	0	0	0	0	0	0
3-27-79	E	7	11	33	126	1,051	246
	L	1	0	0	0	0	<1
4-10-79	E	1,372	1,983	1,239	886	3,914	1,879
	L	0	0	0	1	1	<1
4-26-79	E	11,037	6,788	6,590	374	5,968	6,151
	L	0	0	0	0	1	<1
5-10-79	E	21,132	20,789	3,923	482	3,945	10,054
	L	1	1	2	1	0	1
5-25-79	E	29,158	91,017	6,033	4,969	716	26,379
	L	1	0	1	0	1	1
6-5-79	E	3,655	5,467	2,842	4,927	5,712	4,721
	L	2	0	0	1	2	1
6-19-79	E	14,265	25,277	4,321	1,316	7,542	10,544
	L	1	0	0	0	0	<1
7-3-79	E	24,088	26,945	3,426	659	5,483	12,120
	L	1	0	0	≤0.5	0	<1
7-17-79	E	2,301	12,208	165	1,186	2,310	3,634
	L	0	0	0	0	0	0
7-31-79	E	6,052	7,835	52	27	25,344	7,862
	L	0	0	0	0	0	0
8-14-79	E	570	568	676	681	13,653	3,230
	L	1	0	0	0	0	<1
8-28-79	E	53	39	133	1	783	202
	L	0	0	≤0.5	0	0	<1
9-14-79	E	5	11	531	21	247	163
	L	0	0	0	0	0	0
9-25-79	E	0	1	<0.5	≤0.5	57	12
	L	0	0	0	0	0	0
10-9-79	E	0	0	≤0.5	≤0.5	31	6
	L	0	0	0	0	0	0
10-23-79	E	3	8	4	18	5	8
	L	0	0	0	0	0	0
11-6-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
11-20-79	E	0	2	0	0	0	<1
	L	0	0	0	0	0	0

Note: See abbreviations and footnote at end of table.

Table 5-57. Mean abundance of unidentified sciaenid eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 2 of 2)

Sampling date	Developmental stage	Station A	Station B	Station C	Station D	Station E	Mean
12-4-79	E	0	0	0	≤0.5	≤0.5	≤1
	L	0	0	0	0	0	0
12-18-79	E	0	0	0	0	3	1
	L	0	0	0	0	0	0
1-2-80	E	0	0	0	0	≤0.5	<1
	L	0	0	0	0	0	0
1-17-80	E	≤0.5	≤0.5	0	0	≤0.5	<1
	L	0	0	0	0	≤0.5	<1
1-29-80	E	1	6	≤0.5	0	1	2
	L	≤0.5	0	0	≤0.5	≤0.5	<1
2-12-80	E	0	0	0	0	≤0.5	<1
	L	0	0	0	≤0.5	0	<1

Abbreviations:
E = eggs.
L = larvae.

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-58. Mean abundance of Bairdiella chrysoura eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 1 of 2)

Sampling date	Develop-mental stage	Station A	B	C	D	E	Mean
2-27-79	E	1	1	2	1	3	2
	L	0	0	1	1	1	1
3-13-79	E	13	18	14	3	51	20
	L	4	2	2	2	1	2
3-27-79	E	8	12	14	2	76	22
	L	4	2	4	2	2	3
4-10-79	E	169	42	676	287	2,404	716
	L	6	9	13	9	1	8
4-26-79	E	145	59	302	130	571	241
	L	4	54	14	2	11	17
5-10-79	E	10,306	1,534	2,753	1	35	2,926
	L	4	12	13	7	14	10
5-25-79	E	145	100	26	162	719	230
	L	17	58	14	29	0	24
6-5-79	E	10	698	0	69	440	243
	L	4	4	0	4	5	3
6-19-79	E	2	38	0	1	82	25
	L	2	5	6	3	76	18
7-3-79	E	3	1,294	0	≤0.5	22	264
	L	1	6	1	1	9	9
7-17-79	E	805	478	0	0	80	273
	L	0	0	0	0	2	<1
7-31-79	E	396	793	1	0	1	238
	L	0	0	0	0	1	<1
8-14-79	E	1	31	0	0	5	7
	L	0	0	0	0	≤0.5	<1
8-28-79	E	2	0	0	0	0	<1
	L	0	2	0	0	0	<1
9-14-79	E	≤0.5	0	0	1	2	1
	L	0	0	≤0.5	0	≤0.5	<1
9-25-79	E	0	0	0	0	0	0
	L	0	1	0	0	0	<1
10-9-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
10-23-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
11-6-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
11-20-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0

Note: See abbreviations and footnote at end of table.

Table 5-58. Mean abundance of Bairdiella chrysoura eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 2 of 2)

Sampling date	Developmental stage	Station					Mean
		A	B	C	D	E	
12-4-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
12-18-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
1-2-80	E	0	0	0	0	≤0.5	<1
	L	0	0	0	0	0	0
1-17-80	E	≤0.5	0	≤0.5	0	≤0.5	<1
	L	0	0	0	0	0	0
1-29-80	E	1	1	1	0	0	1
	L	0	0	≤0.5	0	0	<1

Abbreviations:
E = eggs.
L = larvae.

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-59. Mean abundance of *Cynoscion* spp. eggs (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a]

Sampling date	Station A	B	C	D	E	Mean
2-27-79	0	0	0	1	1	<1
3-13-79	1	2	1	1	3	2
3-27-79	1	0	1	0	2	1
4-10-79	0	0	1	0	4	1
4-26-79	2	0	5	1	6	3
5-10-79	16	0	0	0	2	4
5-25-79	2	0	2	0	0	1
6-5-79	0	0	0	0	0	0
6-19-79	0	0	0	≤0.5	0	<1
7-3-79	0	0	0	0	0	0
7-17-79	0	0	0	0	0	0
7-31-79	0	0	0	0	0	0
8-14-79	0	0	0	1	0	0
8-28-79	0	0	0	0	0	0
9-14-79	0	0	0	0	0	0
9-25-79	0	0	0	0	0	0
10-9-79	0	0	0	0	0	0
10-23-79	0	0	0	0	≤0.5	<1
11-6-79	0	0	0	0	0	0
11-20-79	0	0	0	0	0	0
12-4-79	0	0	0	0	0	0
12-18-79	0	0	0	0	0	0
1-2-80	0	0	0	0	0	0
1-17-80	≤0.5	0	0	0	≤0.5	<1
1-29-80	0	<0.5	0	0	0	<1

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-60. Mean abundance of *Pogonias cromis* eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 1 of 2)

Sampling date	Developmental stage	Station A	B	C	D	E	Mean
2-27-79	E	0	1	0	0	1	<1
	L	0	1	0	0	0	<1
3-13-79	E	0	1	0	1	0	<1
	L	1	1	1	1	0	1
3-27-79	E	0	1	1	1	6	2
	L	2	0	2	2	1	1
4-10-79	E	1	0	2	10	101	23
	L	2	0	1	3	1	1
4-26-79	E	1	0	1	9	0	2
	L	4	1	3	0	5	3
5-10-79	E	53	3	0	0	0	11
	L	2	0	2	1	1	1
5-25-79	E	2	0	0	0	4	1
	L	0	4	1	0	0	1
6-5-79	E	1	0	0	0	2	1
	L	2	0	0	≤0.5	0	<1
6-19-79	E	0	0	0	6	2	2
	L	0	1	0	0	0	<1
7-3-79	E	0	0	0	0	0	0
	L	1	0	0	0	0	<1
7-17-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
7-31-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
8-14-79	E	0	0	0	0	0	0
	L	<0.5	0	0	0	0	<1
8-28-79	E	0	0	0	0	0	<0
	L	0	0	<0.5	0	0	1
9-14-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
9-25-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
10-9-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
10-23-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
11-6-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
11-20-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
12-4-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0
12-18-79	E	0	0	0	0	0	0
	L	0	0	0	0	0	0

Note: See abbreviations and footnote at end of table.

Table 5-60. Mean abundance of *Pogonias cromis* eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a] (Sheet 2 of 2)

Sampling date	Developmental stage	Station					Mean
		A	B	C	D	E	
1-2-80	E	≤0.5	≤0.5	0	0	0	<1
	L	0	0	0	0	0	0
1-17-80	E	1	1	1	0	1	1
	L	0	0	0	0	≤0.5	<1
1-29-80	E	0	0	≤0.5	0	0	1
	L	0	0	0	0	0	0
2-12-80	E	0	0	0	≤0.5	≤0.5	<1
	L	0	0	0	0	0	0

Abbreviations:
E = eggs.
L = larvae.

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-61. Mean abundance of *Cynoscion nebulosus* larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a]

Sampling date	Station					Mean
	A	B	C	D	E	
3-13-79	0	1	1	1	0	1
3-27-79	1	0	1	1	1	1
4-10-79	0	1	1	0	0	<1
4-26-79	1	0	0	0	3	1
5-10-79	0	0	1	0	1	<1
5-25-79	3	10	2	0	0	3
6-5-79	2	4	≤0.5	≤0.5	0	1
6-19-79	0	2	≤0.5	0	11	3
7-3-79	4	4	1	1	1	2
7-17-79	0	1	0	0	1	<1
7-31-79	0	0	1	0	1	<1
8-14-79	≤0.5	0	0	0	≤0.5	<1
8-28-79	0	1	0	0	0	<1
9-14-79	≤0.5	≤0.5	0	≤0.5	≤0.5	<1
9-25-79	≤0.5	0	0	0	≤0.5	<1
10-9-79	0	0	0	0	≤0.5	<1
10-23-79	0	0	0	0	≤0.5	<1

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-62. Mean abundance of *Harengula jaguana* eggs and larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a]

Sampling date	Developmental stage	Station					Mean
		A	B	C	D	E	
4-26-79	E	0	0	0	0	≤0.5	<1
	L	1	1	0	0	2	1
5-10-79	E	0	0	0	0	1,275	255
	L	0	0	0	0	70	14
5-25-79	E	6	0	1	0	562	114
	L	520	664	19	4	426	327
6-5-79	E	74	12	0	8	596	138
	L	561	116	8	19	369	215
6-19-79	E	1	145	0	1	767	183
	L	81	14	6	2	45	30
7-3-79	E	1	8	0	0	82	18
	L	1,275	1,020	12	18	245	514
7-17-79	E	6	16	0	0	51	15
	L	24	4	0	≤0.5	16	10
7-31-79	E	0	5	0	0	0	1
	L	0	0	0	1	0	<1

Abbreviations:
E = eggs.
L = larvae.

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-63. Mean abundance of *Menidia beryllina* larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a]

Sampling date	Station				
	A	B	C	D	E
3-27-79	1	1	1	1	0
4-10-79	1	0	0	1	0
4-26-79	0	0	2	0	0
5-10-79	1	0	1	1	0
5-25-79	1	0	0	0	0
6-5-79	1	1	2	0	0
6-19-79	0	1	0	0	0
7-3-79	0	0	1	0	0
7-17-79	0	0	0	0	0
7-31-79	0	0	0	0	0
8-14-79	0	0	0	0	0
8-28-79	0	0	0	0	0
9-14-79	0	≤0.5	0	0	0
9-25-79	0	0	0	0	0
10-9-79	0	0	0	0	0
10-23-79	0	0	0	0	0
11-6-79	0	0	0	0	0
11-20-79	0	0	0	0	0
12-4-79	0	0	0	0	0
12-18-79	0	0	0	0	0
1-2-80	≤0.5	≤0.5	0	0	0
1-17-80	0	0	0	0	≤0.5
1-29-80	0	0	0	0	0
2-12-80	0	0	0	≤0.5	0

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-64. Abundance of non-RIS fish eggs (number per 100 cubic meters) reported from select meroplankton collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a]

Taxon	Period of collection	Sampling date Mar. 27	Apr. 25	May 25	Jun. 19	Jul. 31	Aug. 28	Sep. 25	Oct. 23
Unidentified Clupeidae	D	1	0	0	0	0	0	0	0
	N	0	0	8	0	0	0	0	0
Opistonema oglinum	D	0	0	0	0	0	0	0	0
	N	6	0	0	0	0	0	0	0
Engraulidae	D	0	1	200	0	0	0	0	0
	N	0	25	2,104	0	0	0	0	0
Anchoa hepsetus	D	3	183	189	5	0	0	0	0
	N	0	15	17	0	0	0	0	0
Carangidae	D	0	0	97	0	0	0	0	0
	N	0	0	107	0	0	0	0	0
Soleidae	D	0	6	213	88	0	0	0	0
	N	1	0	1	8	0	0	0	0
Triglidae	D	0	0	0	1	0	0	0	0
	N	0	0	0	0	0	0	0	0

Abbreviations:
RIS = representative important species.
D = daytime collection.
N = nighttime collection.

[a] Adapted from Phillips and Blanchet (1980b).

Table 5-65. Abundance of non-RIS fish larvae (number per 100 cubic meters) reported from select meroplankton collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 1 of 2)

Taxon	Period of collection	Sampling date							
		Mar. 27	Apr. 25	May 25	Jun. 19	Jul. 31	Aug. 28	Sep. 25	Oct. 23
Clupeidae	D	0	0	0	< 1	0	0	0	0
	N	0	0	0	0	0	0	0	0
Anchoa hepsetus	D	0	0	0	0	1	0	0	0
	N	0	0	2	1	0	0	0	0
Gobiesox strumosus	D	3	3	1	1	0	0	0	1
	N	1	0	3	0	0	0	0	0
Membras martinica	D	0	0	0	0	1	0	0	0
	N	< 1	0	2	43	3	0	1	0
Syngnathus louisianae	D	0	0	0	0	0	0	0	0
	N	< 1	0	0	0	0	0	0	0
Carangidae	D	0	0	1	0	0	0	0	0
	N	0	0	20	0	0	0	0	0
Chloroscombrus chrysurus	D	0	0	1	1	0	0	0	0
	N	0	0	2	1	0	0	0	0
Oligoplites saurus	D	0	0	2	1	0	0	0	0
	N	0	0	4	2	0	0	0	0
Cynoscion arenarius	D	1	11	2	2	0	0	1	0
	N	0	14	31	9	0	2	9	1
Orthopristis chrysoptera	D	0	0	1	1	0	0	0	0
	N	0	0	0	1	0	0	0	0
Menticirrhus spp.	D	6	9	19	4	0	2	< 1	0
	N	2	7	5	1	2	< 1	1	0
Unidentified Sciaenidae	D	0	0	0	7	0	0	0	0
	N	0	0	0	2	0	0	0	0
Archosargus probatocephalus	D	0	0	0	0	0	0	0	0
	N	0	0	13	0	0	0	0	0
Blenniidae	D	0	0	0	0	0	0	0	0
	N	0	2	0	0	0	0	0	0
Hypsoblennius hentzi	D	1	18	4	9	1	1	0	1
	N	3	7	57	6	0	0	1	1

Note: See abbreviations and footnote at end of table.

Table 5-65. Abundance of non-RIS fish larvae (number per 100 cubic meters) reported from select meroplankton collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 2 of 2)

Taxon	Period of collection	Sampling date Mar. 27	Apr. 25	May 25	Jun. 19	Jul. 31	Aug. 28	Sep. 25	Oct. 23
Gobiosoma robustum	D	0	0	0	0	2	0	<1	<1
	N	4	5	10	4	3	1	2	<1
Microgobius gulosus	D	0	0	0	0	1	0	0	0
	N	<1	2	2	16	2	1	1	<1
Prionotus sp.	D	0	0	0	0	0	0	0	0
	N	<1	19	44	3	0	0	0	<1
Unidentified Soleidae	D	0	0	0	0	0	0	0	0
	N	0	2	0	0	0	0	0	0
Achirus lineatus	D	0	3	6	15	1	2	<1	0
	N	0	2	4	2	3	<1	1	0
Symphurus plagiusa	D	0	0	1	0	0	0	0	0
	N	0	0	0	0	0	0	0	0
Unidentified	D	2	2	11	1	0	2	<1	0
	N	2	12	24	4	0	0	0	0

Abbreviations:
RIS = representative important species.
D = daytime collection.
N = nighttime collection.

[a] Adapted from Phillips and Blanchet (1980b).

Table 5-66. Mean abundance and relative composition of all RIS and non-RIS fish eggs reported from select meroplankton collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a]

Taxon	Mean number per 100 cubic meters	Percent of total
Anchoa mitchilli[b]	7,671.81	49.988
Unidentified Sciaenidae[b]	7,377.75	48.071
Unidentified Engraulidae	145.63	0.949
Bairdiella chrysoura[b]	90.50	0.590
Anchoa hepsetus	26.75	0.174
Unidentified Soleidae	19.81	0.129
Unidentified Carangidae	12.75	0.083
Cynoscion spp.[b]	0.62	0.004
Unidentified Clupeidae	0.50	0.003
Pogonias cromis[b]	0.48	0.003
Harengula jaguana[b]	0.36	0.002
Opisthonema oglinum	0.36	0.002
Unidentified Triglidae	0.05	0.001

Abbreviation: RIS = representative important species.

[a] Adapted from Phillips and Blanchet (1980b).
[b] RIS taxon.

Table 5-67. Mean abundance and relative composition of all RIS and non-RIS fish larvae reported from select meroplankton collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a]

Taxon	Mean number per 100 cubic meters	Percent of total
Anchoa mitchilli[b]	337.75	74.421
Harengula jaguana[b]	74.00	16.305
Hypsoblennius hentzi	6.88	1.516
Cynoscion arenarius	5.08	1.119
Prionotus spp.	4.15	0.914
Bairdiella chrysoura[b]	3.94	0.868
Unidentified larvae	3.77	0.831
Menticirrhus spp.	3.41	0.751
Membras martinica	3.02	0.665
Gobiosoma robustum	1.98	0.436
Achirus lineatus	1.97	0.434
Microgobius gulosus	1.59	0.350
Unidentified Carangidae	1.31	0.289
Gobiesox strumosus	1.06	0.233
Archosargus probatocephalus	0.81	0.178
Unidentified Sciaenidae[b]	0.81	0.178
Pogonias cromis[b]	0.63	0.139
Oligoplites saurus	0.56	0.123
Chloroscombrus chrysurus	0.31	0.068
Orthopristis chrysoptera	0.19	0.042
Menidia beryllina[b]	0.13	0.029
Unidentified Soleidae	0.13	0.029
Unidentified Blenniidae	0.13	0.029
Cynoscion nebulosus[b]	0.11	0.024
Symphurus plagiusa	0.06	0.013
Syngnathus louisianae	0.03	0.007
Unidentified Clupeidae	0.03	0.007

Abbreviation: RIS = representative important species.

[a] Adapted from Phillips and Blanchet (1980b).
[b] RIS taxon.

Table 5-68. Mean abundance of *Menippe mercenaria* zoeal larvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a]

Sampling date	Station					Mean
	A	B	C	D	E	
3-13-79	2	0	1	0	0	1
3-27-79	1	7	2	0	0	2
4-10-79	89	69	5	2	7	34
4-26-79	469	207	6	3	48	147
5-10-79	141	126	22	8	12	61
5-25-79	917	4,283	12	12	29	1,051
6-5-79	401	2,298	27	22	38	556
6-19-79	94	218	6	4	42	73
7-3-79	1,006	2,035	33	42	112	645
7-17-79	115	479	2	11	214	164
7-31-79	48	245	54	3	89	87
8-14-79	47	181	2	≤0.5	34	53
8-28-79	11	49	10	4	29	21
9-14-79	8	15	4	2	10	8
9-25-79	2	11	3	2	5	5
10-9-79	≤0.5	1	≤0.5	0	2	1
10-23-79	0	0	≤0.5	≤0.5	1	<1
11-6-79	2	1	1	1	1	1
11-20-79	≤0.5	1	0	0	1	<1
12-4-79	1	2	≤0.5	0	0.5	1
12-18-79	≤0.5	1	≤0.5	0	0	<1

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-69. Mean abundance of *Penaeus duorarum* postlarvae (number per 100 cubic meters) reported from meroplankton collections made during day and night periods at five stations near Big Bend from February 1979 to February 1980[a]

Sampling date	Station				
	A	B	C	D	E
5-10-79	0	0	0	0	≤ 0.5
5-25-79	0	0	0	0	0
6-5-79	0	0	0	0	0
6-19-79	0	0	1	≤ 0.5	2
7-3-79	1	5	2	0	1
7-17-79	1	4	2	4	15
7-31-79	6	31	5	3	1
8-14-79	0	1	≤ 0.5	1	0
8-28-79	1	1	1	1	0
9-14-79	0	1	1	1	2
9-25-79	21	14	4	1	3
10-9-79	0	0	0	0	0
10-23-79	0	0	1	0	0
11-6-79	0	1	0	0	0
11-20-79	0	0	0	0	1
12-4-79	0	0	≤ 0.5	0	0
12-18-79	0	0	0	0	1

[a] Adapted from Phillips and Blanchet (1980a) and Robinson (1981).

Table 5-70. Abundance (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 1 of 7)

Taxon	Period of collection	Sampling date Mar. 27	Apr. 26	May 25	June 19	July 31	Aug. 28	Sept. 25	Oct. 23
Decapoda									
Penaeidae									
Penaeus	D	0.00	0.00	0.00	0.00	0.01	0.00	0.00	< 0.01
duorarum[b]	N	0.00	0.00	0.00	0.00	0.09	0.00	0.42	0.00
Trachypenaeus	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
spp.	N	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Sicyonia	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
spp.	N	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Palaemonidae									
Palaemonetes	D	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
intermedius	N	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Palaemonetes	D	0.57	0.13	0.18	0.55	0.37	0.02	0.00	0.03
pugio/vulgaris	N	0.03	0.04	0.13	1.28	0.28	0.09	0.21	0.01
Palaemonetes	D	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00
spp.	N	0.00	0.03	0.00	0.00	0.04	0.00	0.00	0.00
Periclimenes	D	0.00	0.73	0.22	0.00	0.00	0.00	0.00	0.00
spp.	N	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Alpheidae									
Alpheidae	D	0.07	0.92	3.63	1.20	0.13	0.03	0.04	0.01
sp. A	N	0.19	0.27	1.67	1.22	0.04	0.02	0.00	0.01
Alpheidae	D	0.00	0.02	0.09	0.10	0.01	0.00	0.00	0.00
sp. B	N	0.00	0.00	0.13	0.02	0.00	0.00	0.00	0.00
Alpheidae	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sp. D	N	0.00	0.00	0.00	0.42	0.00	0.00	0.00	0.00
Alpheidae	D	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
sp. E	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Alpheidae	N	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00

Note: See abbreviations and footnotes at end of table.

Table 5-70. Abundance (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 2 of 7)

Taxon	Period of collection	Sampling date Mar. 27	Apr. 26	May 25	June 19	July 31	Aug. 28	Sept. 25	Oct. 23
Decapoda (continued)									
Hippolytidae									
Hippolyte	D	0.33	0.16	0.46	0.00	0.03	0.03	0.00	0.01
spp.	N	0.19	0.17	0.13	0.10	0.00	0.00	0.00	< 0.01
Processidae									
Ambidexter	D	0.07	0.09	0.09	0.16	0.00	0.01	0.00	0.00
symmetricus	N	0.01	0.00	0.00	0.12	0.00	0.00	0.00	0.00
Ogyrididae									
Ogyrides	D	0.00	0.15	0.89	0.65	0.04	0.07	0.01	0.00
limicola	N	0.00	0.00	0.00	1.56	0.05	0.04	0.04	0.00
Unidentified	D	0.00	0.00	0.23	0.05	0.09	0.00	0.00	0.00
Caridea	N	0.00	0.02	0.13	0.00	0.00	0.00	0.00	< 0.01
Callianassidae									
Upogebia	D	3.20	6.15	23.09	11.91	0.76	0.45	<0.01	0.02
affinis	N	0.45	0.95	2.82	3.03	0.63	0.15	0.21	0.00
Callianassa	D	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00
sp. A	N	0.00	0.00	0.00	0.04	0.16	0.01	0.05	0.00
Callianassa	D	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.00
sp. B	N	< 0.01	0.02	0.00	0.00	0.20	0.00	0.00	0.00
Callianassa	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sp. C	N	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Callianassa	D	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
sp. D	N	0.00	0.10	0.00	0.72	0.13	0.00	0.10	< 0.01
Unidentified	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Callianassidae	N	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.00

Note: See abbreviations and footnotes at end of table.

Table 5-70. Abundance (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 3 of 7)

Taxon	Period of collection	Sampling date Mar. 27	Apr. 26	May 25	June 19	July 31	Aug. 28	Sept. 25	Oct. 23
Decapoda (continued)									
Laomediidae									
Naushonia	D	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00
sp.	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paguridae									
Pagurus	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
annulipes	N	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00
Pagurus	D	0.13	0.17	0.27	0.00	0.00	0.00	0.00	0.00
longicarpus	N	0.06	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Pagurus	D	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
pollicaris	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paguridae	D	0.01	0.18	0.08	0.00	0.01	0.02	0.00	0.00
sp. A	N	0.01	0.00	0.00	0.00	0.20	0.02	0.00	0.00
Paguridae	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
sp. B	N	< 0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paguridae	N	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Porcellanidae									
Euceramus	D	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
praelongus	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petrolisthes	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
spp.	N	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00
Polyonyx	D	0.01	1.36	2.75	0.78	0.49	0.10	0.01	0.00
gibbesi	N	0.00	0.49	0.26	0.16	0.45	7.29	0.02	0.01
Unidentified	D	0.00	0.07	0.45	0.00	0.00	0.00	0.00	0.00
Porcellanidae	N	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00

Note: See abbreviations and footnotes at end of table.

Table 5-70. Abundance (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 4 of 7)

Taxon	Period of collection	Sampling date Mar. 27	Apr. 26	May 25	June 19	July 31	Aug. 28	Sept. 25	Oct. 23
Decapoda (continued)									
Albuneidae									
Unidentified	D	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Albuneidae	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Leucosiidae									
Persephona	D	0.00	0.02	0.02	0.05	0.01	0.01	0.00	0.00
mediterranea	N	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00
Portunidae									
Portunidae	D	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00
sp. B	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Xanthidae									
Eurypanopeus	D	3.06	9.31	98.97	4.50	0.49	1.60	0.12	1.53
depressus	N	0.43	0.93	1.28	5.85	0.09	0.14	1.19	0.43
Hexapanopeus	D	3.78	16.88	33.32	2.21	0.30	0.43	0.60	0.24
angustifrons	N	0.56	0.66	1.15	2.48	0.76	0.33	0.21	0.06
Menippe	D	0.01	9.96	15.68	1.65	0.41	0.13	0.01	0.00
mercenaria[b]	N	0.00	0.25	3.92	0.38	0.32	0.04	0.01	0.00
Neopanope	D	0.09	0.53	3.49	1.25	0.09	0.12	0.05	0.10
texana	N	0.01	0.03	0.13	0.44	0.14	0.00	0.03	0.02
Panopeus	D	0.12	1.40	7.40	0.08	0.04	0.05	0.01	0.04
herbstii	N	0.03	0.17	0.00	2.64	0.00	0.00	0.00	<0.01
Pilumnus	D	0.03	0.02	0.03	0.00	0.00	0.00	0.00	0.00
spp.	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rhithropanopeus	D	0.04	0.00	0.00	2.28	2.59	0.44	< 0.01	0.35
harrisii	N	< 0.01	0.00	0.00	10.81	0.00	0.16	0.41	0.02
Unidentified	D	0.17	1.06	12.55	2.31	1.20	0.54	0.05	0.22
Xanthidae	N	0.07	0.37	0.00	2.13	0.02	0.07	0.04	0.02

Note: See abbreviations and footnotes at end of table.

Table 5-70. Abundance (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 5 of 7)

Taxon	Period of collection	Sampling date							
		Mar. 27	Apr. 26	May 25	June 19	July 31	Aug. 28	Sept. 25	Oct. 23
Decapoda (continued)									
Pinnotheridae									
Pinnixa	D	0.04	0.06	5.73	2.18	0.15	0.03	0.00	0.00
chaetopterana	N	0.01	0.07	2.82	2.36	0.10	0.01	0.00	< 0.01
Pinnixa	D	0.84	6.68	28.03	67.21	22.03	4.44	0.17	0.05
sayana	N	0.42	0.48	18.85	43.67	39.75	11.84	0.13	0.01
Pinnotheres	D	0.00	0.06	0.80	1.07	0.05	0.19	< 0.01	< 0.01
maculatus	N	0.00	0.02	0.13	0.75	0.17	0.00	0.01	0.00
Pinnotheres	D	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
sp. A	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified	D	0.09	0.07	2.97	1.42	0.35	0.06	0.00	0.00
Pinnotheridae	N	0.01	0.08	0.26	2.34	0.83	0.09	0.00	< 0.01
Grapsidae									
Sesarma	D	0.00	0.00	0.36	0.60	0.12	0.00	0.00	0.00
cinereum	N	0.00	0.00	0.16	0.00	0.00	0.00	0.00	< 0.01
Sesarma	D	0.00	0.52	1.23	0.80	0.05	0.10	0.00	0.15
reticulatum	N	0.01	0.01	0.00	0.54	0.11	0.03	0.18	0.03
Ocypodidae									
Uca	D	0.00	0.11	2.89	5.11	0.20	0.02	0.00	0.00
spp.	N	0.00	0.02	0.00	0.38	0.08	0.00	0.00	0.00
Unidentified Brachyura									
Brachyura	D	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
sp. A	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Brachyura	D	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
sp. B	N	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Unidentified	D	0.00	0.00	2.68	0.76	0.06	0.02	0.00	0.00
Grapsizoea	N	0.00	0.00	0.13	0.32	0.11	0.00	0.01	0.00

Note: See abbreviations and footnotes at end of table.

Table 5-70. Abundance (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 6 of 7)

Taxon	Period of collection	Sampling date Mar. 27	Apr. 26	May 25	June 19	July 31	Aug. 28	Sept. 25	Oct. 23
Decapoda (continued)									
Unidentified	D	0.37	0.67	7.27	0.35	0.17	0.09	0.00	0.00
Brachyura	N	0.03	0.21	0.26	0.39	0.11	0.00	0.00	0.00
Unidentified	D	0.04	0.00	0.22	0.00	0.00	0.01	0.00	0.00
Decapoda	N	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.00
Cirripedia									
Balanus	D	0.23	0.43	10.89	1.22	0.00	0.00	0.00	<0.01
spp.	N	1.35	0.08	3.08	0.53	0.00	0.00	0.00	0.02
Isopoda									
Aegathoa	D	0.14	0.00	0.00	0.00	0.11	0.00	0.04	<0.01
sp.	N	0.68	0.16	0.00	0.06	0.11	0.06	0.02	0.03
Xiphosura									
Limulus	D	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
polyphemus	N	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Mollusca		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gastropoda	D	0.00	0.02	0.44	0.08	0.00	0.00	<0.01	0.00
	N	0.01	0.09	0.26	0.43	0.00	0.01	0.00	0.01
Pelecypoda	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	N	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cephalopoda									
Lolliguncula	D	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
brevis	N	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00

Note: See abbreviations and footnotes at end of table.

Table 5-70. Abundance (number per cubic meter) of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 7 of 7)

Taxon	Period of collection	Sampling date							
		Mar. 27	Apr. 26	May 25	June 19	July 31	Aug. 28	Sept. 25	Oct. 23
Echinodermata	D	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
	N	0.00	0.00	0.00	0.00	0.00	0.01	0.00	<0.01
Polychaeta	D	0.25	1.34	0.45	0.78	0.02	0.02	0.00	0.01
	N	0.38	0.29	0.51	0.37	0.00	0.00	0.02	0.01

Abbreviations:
RIS = representative important species.
D = daytime collection.
N = nighttime collection.

[a] Adapted from Phillips and Blanchet (1980b).
[b] Denotes an RIS taxon.

Table 5-71. Mean abundance and relative composition of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 1 of 2)

Taxon	Mean number per cubic meter	Percent of total
Pinnixa sayana	15.231	34.77
Eurypanopeus depressus	8.120	18.54
Hexapanopeus angustifrons	3.995	9.12
Upogebia affinis	3.359	7.67
Menippe mercenaria[b]	2.047	4.67
Unidentified Xanthidae	1.340	3.06
Balanus spp.	1.114	2.54
Rhithropanopeus harrisii	1.069	2.44
Polyonyx gibbesi	0.886	2.02
Pinnixa chaeopterana	0.815	1.86
Panopeus herbstii	0.750	1.71
Unidentified Brachyura	0.620	1.42
Alpheidae sp. A	0.591	1.35
Uca spp.	0.551	1.26
Unidentified Pinnotheridae	0.536	1.22
Neopanope texana	0.406	0.93
Polychaeta	0.278	0.63
Unidentified grapsizoea	0.256	0.58
Palemonetes pugio/*vulgaris*	0.245	0.56
Sesarma reticulatum	0.235	0.54
Ogyrides limicola	0.219	0.50
Pinnotheres maculatus	0.204	0.47
Hippolyte spp.	0.101	0.23
Aegathoa sp.	0.088	0.20
Gastropod	0.085	0.19
Sesarma cinereum	0.078	0.18
Callianassa sp. D	0.070	0.16
Palaemonetes spp.	0.064	0.15
Periclimenes spp.	0.061	0.14
Pagurus longicarpus	0.042	0.10
Ambidexter symmetricus	0.034	0.08
Unidentified Porcellanidae	0.033	0.08
Paguridae sp. A	0.033	0.08
Penaeus duorarum[b]	0.033	0.08
Unidentified Caridea	0.033	0.08
Alpheidae sp. D	0.026	0.06
Alpheidae sp. B	0.023	0.05
Portunidae sp. B	0.021	0.05
Callianassa sp. A	0.019	0.04
Unidentified decapod	0.019	0.04
Callianassa sp. B	0.016	0.04
Persephone mediterranea	0.009	0.02

Note: See abbreviation and footnotes at end of table.

Table 5-71. Mean abundance and relative composition of all RIS and non-RIS invertebrate meroplankton reported from select collections made in the intake canal (Station A) of the Big Bend Powerplant from March to October 1979[a] (Sheet 2 of 2)

Taxon	Mean number per cubic meter	Percent of total
Alpheidae sp. E	0.009	0.02
Unidentified Alpheidae	0.009	0.02
Naushonia sp.	0.007	0.02
Pilumnus spp.	0.005	0.01
Euceramus praelongus	0.003	0.01
Petrolisthes spp.	0.003	0.01
Lolliguncula brevis	0.003	0.01
Limulus polyphemus	0.003	0.01
Echinodermata	0.002	0.01
Unidentified Paguridae	0.002	0.01
Pagurus annulipes	0.002	0.01
Unidentified Callianassidae	0.002	0.01
Pagurus pollicaris	0.001	0.01
Brachyura sp. B	0.001	0.01
Brachyura sp. A	0.001	0.01
Callianassa sp. C	0.001	0.01
Pinnotheres sp. A	0.001	0.01
Unidentified Albuneidae	0.001	0.01
Palaemonetes intermedius	0.001	0.01
Sicyonia sp.	0.001	0.01
Trachypenaeus sp.	0.001	0.01
Bivalvia	0.001	0.01
Paguridae sp. B.	0.001	0.01

Abbreviation: RIS = representative important species.

[a] Adapted from Phillips and Blanchet (1980b).
[b] RIS taxon.

Table 5-72. Molluscan taxa reported from collections made in Hillsborough Bay during August and September 1963[a] (Sheet 1 of 2)

Gastropoda

- Neritidae
  - *Neritina reclivata*
- Rissoidae
  - *Rissoina chesneli*
- Vitrinellidae
  - *Cyclostremiscus* sp.
- Cerithiidae
  - *Bittium varium*[b]
  - *Seila adamsi*
- Triphoridae
  - *Triphora nigrocincta*
- Epitoniidae
  - *Epitonium angulatum*[b]
  - *Epitonium humphreysi*[b]
  - *Epitonium rupicola*
- Calyptraeidae
  - *Crepidula tornicata*[b]
  - *Crepidula plana*[b]
- Naticidae
  - *Natica pusilla*[b]
  - *Polinicies duplicatus*[b]
- Muricidae
  - *Urosalpinx tampaensis*[b]
- Columbellidae
  - *Anachis obesa*b
  - *Anachis simiplicata*
  - *Mitrella lunata*[b]
- Melongenidae
  - *Melongena corona*[b]
- Nassariidae
  - *Nassarius vibex*[b]
- Olividae
  - *Olivella perplexa*
- Marginellidae
  - *Prunum apicinum*
- Atyidae
  - *Haminoea succinea*[b]
- Retusidae
  - *Retusa canaliculata*[b]
- Pyramidellidae
  - *Odostomia acutidens*[b]
  - *Odostomia impressa*
  - *Odostomia producta*
  - *Turbonilla conradi*
- Acteocinidae
  - *Cylichna bidentata*
- Acteonidae
  - *Acteon punctostriatus*[b]
- Ellobiidae
  - *Melampus coffeus*

Amphineura

- Ischnochitoniidae
  - *Ischnochiton papillosus*[b]

Bivalvia

- Nuclidae
  - *proxima*[b]
- Nucalanidae
  - *Nucalana acuta*
- Arcidae
  - *Anadara transversa*[b]
- Mytilidae
  - *Amygdalum papyria*[b]
  - *Brachidontes exustus*[b]
  - *Modiolus americanus*[b]
  - *Modiolus demissus granosissima*
- Pinnidae
  - *Atrina rigida*
- Ostreidae
  - *Crassostrea virginica*[b]
- Carditidae
  - *Cardita floridana*
- Corbiculiidae
  - *Polymesoda caroliniana*[b]
- Leptonidae
  - *Mysella planulata*[b]
- Cardiidae
  - *Laevicardium mortoni*[b]
- Veneridae
  - *Chione cancellata*
  - *Mercenaria campechiensis*[b]

Note: See footnotes at end of table.

Table 5-72. Molluscan taxa reported from collections made in Hillsborough Bay during August and September 1963[a] (Sheet 2 of 2)

Bivalvia (continued)

- *Parastarte triquetra*
- Petricolidae
  - *Petricola pholadiformis*
- Tellinidae
  - *Macoma constricta*
  - *Macoma tenta*[b]
  - *Tellina alternata*
  - *Tellina lineata*
  - *Tellina versicolor*[b]
- Semelidae
  - *Semele bellastriata*
  - *Semele proficua*
- Donacidae
  - *Donax variabilis*
- Sanguinolariidae
  - *Tagelus divisus*[b]
  - *Tagelus plebeius*[b]
- Solenidae
  - *Ensis minor*[b]
- Mactridae
  - *Mactra fragilis*
  - *Mulinia lateralis*[b]
- Corbulidae
  - *Corbula barratiana*[b]
  - *Corbula caribaea*[b]
- Pholadidae
  - *Cyrtopleura costata*
- Lyonsiidae
  - *Lyonsia hyalina floridana*
- Thraciidae
  - *Thraccia* sp.[b]

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[a] Adapted from Taylor, Hall, and Saloman (1971).

[b] Taxon was collected alive.

Table 5-73. Relative abundance of the 25 most common organisms (invertebrates and fish) reported from seine collections made at Station SB-1 near Big Bend during 1973-1975[a]

Taxon	Phylum	Percent of total
Anchoa mitchilli	Chordata	37.39
Eucinostomus argenteus	Chordata	13.07
Eucinostomus gula	Chordata	10.07
Melongena corona	Mollusca	5.90
Trachinotus falcatus	Chordata	5.35
Oligoplites saurus	Chordata	5.08
Membras martinica	Chordata	4.08
Fundulus similis	Chordata	3.18
Sciaenops ocellata	Chordata	1.72
Hyporhamphus unifasciatus	Chordata	1.54
Callinectes sapidus	Arthropoda	1.45
Pagurus longicarpus	Arthropoda	1.45
Menidia beryllina	Chordata	1.09
Elops saurus	Chordata	0.73
Mugil trichodon	Chordata	0.64
Strongylura timucu	Chordata	0.54
Strongylura notata	Chordata	0.54
Archosargus probatocephalus	Chordata	0.54
Polinices duplicatus	Mollusca	0.45
Crepidula plana	Mollusca	0.45
Lagodon rhomboides	Chordata	0.45
Unidentified gerrid	Chordata	0.45
Penaeus duorarum	Arthropoda	0.27
Microgobius gulosus	Chordata	0.27
Unidentified nereid	Annelida	0.18
Total		96.88

[a] Adapted from Tampa Electric Company (1975a).

Table 5-74. Relative abundance of the 25 most common organisms (invertebrates and fish) reported from seine collections made at Station SB-3 near Big Bend during 1973-1975[a]

Taxon	Phylum	Percent of total
Menidia beryllina	Chordata	21.13
Harengula jaguana	Chordata	19.18
Eucinostomus argenteus	Chordata	18.29
Unidentified gerrid	Chordata	13.69
Eucinostomus gula	Chordata	5.77
Anchoa mitchilli	Chordata	4.10
Melongena corona	Mollusca	2.72
Portunus gibbesii	Arthropoda	2.02
Neopanope texana	Arthropoda	1.20
Lagodon rhomboides	Chordata	1.13
Strongylura timucu	Chordata	1.06
Brevoortia sp.	Chordata	0.88
Callinectes sapidus	Arthropoda	0.78
Fundulus similis	Chordata	0.78
Pagurus longicarpus	Arthropoda	0.71
Penaeus duorarum	Arthropoda	0.67
Palaemonetes pugio	Arthropoda	0.50
Menticirrhus focaliger	Chordata	0.50
Trachinotus falcatus	Chordata	0.50
Menticirrhus americanus	Chordata	0.46
Oligoplites saurus	Chordata	0.46
Mugil cephalus	Chordata	0.42
Oliva sayana	Mollusca	0.35
Amygdalum papyrium	Mollusca	0.25
Hyporhamphus unifasciatus	Chordata	0.21
Total		97.76

[a] Adapted from Tampa Electric Company (1975a).

Table 5-75. Relative abundance of the 25 most common organisms (invertebrates and fish) reported from trawl collections made on Transect TB-2 in the discharge canal of the Big Bend Powerplant during 1973-1975[a]

Taxon	Phylum	Percent of total
Melongena corona	Mollusca	25.19
Crepidula plana	Mollusca	18.15
Molgula sp.	Chordata	14.93
Amphipoda	Arthropoda	9.88
Hexapanopeus angustifrons	Arthropoda	2.68
Callinectes sapidus	Arthropoda	2.60
Pagurus longicarpus	Arthropoda	2.45
Pagurus pollicaris	Arthropoda	1.91
Neopanope texana	Arthropoda	1.84
Penaeus duorarum	Arthropoda	1.76
Lolliguncula brevis	Mollusca	1.53
Chaetodipterus faber	Chordata	1.23
Eurypanopeus depressus	Arthropoda	1.23
Cynoscion arenarius	Chordata	1.00
Pogonias cromis	Chordata	1.00
Mitrella lunata	Mollusca	0.84
Diapterus plumieri	Chordata	0.84
Micropogon undulatus	Chordata	0.84
Unidentified xanthid crabs	Arthropoda	0.69
Palaemon floridanus	Arthropoda	0.54
Styela plicata	Chordata	0.54
Anchoa mitchilli	Chordata	0.54
Archosargus probatocephalus	Chordata	0.46
Mugil sp.	Chordata	0.46
Limulus polyphemus	Arthropoda	0.38
Total		93.51

[a] Adapted from Tampa Electric Company (1975a).

Table 5-76. Relative abundance of the 25 most common organisms (invertebrates and fish) reported from trawl collections made on Transect TB-3 near Big Bend during 1973-1975[a]

Taxon	Phylum	Percent of total
Brittle stars, unidentified sp.	Echinodermata	87.03
Anemone, unidentified sp.	Coelenterata	5.50
Luidia clathrata	Echinodermata	1.69
Bairdiella chrysoura	Chordata	0.70
Orthopristis chrysopteris	Chordata	0.60
Chaetodipterus faber	Chordata	0.57
Chloroscombrus chrysura	Chordata	0.48
Anchoa mitchilli	Chordata	0.36
Menticirrhus americanus	Chordata	0.34
Penaeus duorarum	Arthropoda	0.23
Portunus gibbesi	Arthropoda	0.21
Polyonyx gibbesii	Arthropoda	0.19
Prionotus scitulus	Chordata	0.17
Molgula sp.	Chordata	0.14
Leiostomus xanthurus	Chordata	0.11
Lolliguncula brevis	Mollusca	0.11
Arius felis	Chordata	0.10
Symphurus plaguisa	Chordata	0.10
Lagodon rhomboides	Chordata	0.10
Chaetopterus variopedatus	Annelida	0.08
Cynoscion arenarius	Chordata	0.08
Glottidia pyramidata	Brachiopoda	0.06
Anchoa hepsetus	Chordata	0.05
Crepidula plana	Mollusca	0.05
Libinia dubia	Arthropoda	0.05
Total		99.10

[a] Adapted from Tampa Electric Company (1975a).

Table 5-77. Relative abundance of the 25 most common organisms (invertebrates and fish) reported from trawl collections made on Transect TB-4 near the Big Bend Powerplant during 1973-1975[a]

Taxon	Phylum	Percent of total
Neopanope texana	Arthropoda	15.84
Mulinia lateralis	Mollusca	14.81
Cynoscion arenarius	Chordata	13.54
Anchoa mitchilli	Chordata	11.88
Penaeus duorarum	Arthropoda	7.79
Lolliguncula brevis	Mollusca	5.11
Hexapanopeus angustifrons	Arthropoda	3.70
Squilla empusa	Arthropoda	2.68
Bairdiella chrysoura	Chordata	2.68
Callinectes sapidus	Arthropoda	2.17
Portunus gibbesii	Arthropoda	2.17
Menticirrhus americanus	Chordata	1.53
Platynereis dumerilii	Annelida	1.40
Micropogon undulatus	Chordata	1.28
Trinectes maculatus	Chordata	1.28
Palaemonetes vulgaris	Arthropoda	1.15
Alpheus heterochaelis	Arthropoda	1.02
Luidia clathrata	Echinodermata	1.02
Styela plicata	Chordata	0.89
Anadara transversa	Mollusca	0.77
Macoma tenta	Mollusca	0.64
Corbula sp.	Mollusca	0.51
Glottidia pyramidata	Brachiopoda	0.51
Prunum apicunum	Mollusca	0.38
Pagurus longicarpus	Arthropoda	0.38
Total		95.13

[a]Adapted from Tampa Electric Company (1975a).

Table 5-78. Macroinvertebrate taxa reported from impingement studies conducted at the Big Bend Powerplant during 1972-1975[a]

Mollusca	
Modiolus demissus	*Cyrtopleura costata*
Crassostrea virginica	*Lolliguncula brevis*
Arthropoda	
Limulus polyphemus	*Portunus gibbesii*
Squilla empusa	*Pagurus* spp.
Penaeus duorarum	*Petrolisthes armatus*
Penaeus setiferus	*Eurypanopeus depressus*
Trachypeneus constrictus	*Hexapanopeus angustifrons*
Palaemonetes intermedius	*Menippe mercenaria*
Alpheus armillatus	*Neopanope texana*
Alpheus heterochaelis	*Panopeus herbstii*
Unidentified shrimp	*Sesarma cinereum*
Upogebia affinis	*Sesarma reticulatum*
Callinectes sapidus	*Metoporhapsis calcarata*
	Insecta
Chordata	
Molgula manhattensis	*Styela plicata*

[a] Adapted from Tampa Electric Company (1975a).

Table 5-79. Total numbers of macroinvertebrates collected by trawl on seven transects near Big Bend from June 1976 to February 1977[a]

Transect	Total number of macroinvertebrates	Percent of total catch
TB-1	15	3.9
TB-12	25	6.5
TB-5	53	13.8
TB-7	34	8.9
TB-6	19	5.0
TB-13	198	51.7
TB-4	39	10.2
Total	383	100.0

[a]Adapted from Comp (1977).

Table 5-80. Total numbers of macroinvertebrates (excluding *Molgula* sp.) collected by trawl on seven transects near Big Bend from June 1976 to February 1977[a]

Transect	Total number of macroinvertebrates	Percent of total catch
TB-1	15	7.0
TB-12	22	10.3
TB-5	53	24.9
TB-7	34	16.0
TB-6	19	8.9
TB-13	31	14.6
TB-4	39	18.3
Total	213	100.0

[a]Adapted from Comp (1977).

Table 5-81. Seasonal occurrence of macroinvertebrate taxa reported from impingement collections made at the Big Bend Powerplant from January 1976 to March 1977[a]

Taxon	Jan.-March	April-June	July-Sept.	Oct.-Dec.	Jan.-March
Aurelia aurita	X	X	X	X	
Chrysura quinquecirrha			X	X	X
Aplysia willcoxi		X			
Lolliguncula brevis	X	X	X	X	X
Squilla empusa	X	X		X	X
Limulus polyphemus	X	X	X	X	X
Penaeus duorarum	X	X	X	X	X
Trachypenaeus constrictus	X	X		X	X
Alpheus heterochalis	X	X		X	X
Upogebia sp.		X			
Petrolisthes armatus	X			X	X
Petrolisthes sp.			X	X	
Pagurus longicarpus				X	X
Portunus gibbesii	X	X	X	X	X
Portunus sp.			X	X	
Callinectes ornatus	X	X			
Callinectes sapidus	X	X	X	X	X
Callinectes sp.			X	X	
Menippe mercenaria	X	X	X	X	X
Hexapanopeus angustifrons		X	X		
Neopanope texana texana	X	X	X	X	X
Eurypanopeus depressus	X	X	X	X	X
Panopeus herbstii	X	X	X	X	X
Sesarma cinerium	X	X	X	X	X
Sesarma reticulatum	X	X	X	X	X
Libinia dubia	X		X		X
Molgula sp.	X	X	X	X	X

[a]Adapted from Peekstok, Page, and Haynes (1977).

Table 5-82. Abundance of RIS taxa (invertebrates and fish) reported from seine collections made at four stations near Big Bend from March 1979 to January 1980[a] (Sheet 1 of 2)

	Collection date by station																											
	3/14/79				4/10/79				5/10/79				6/5/79				7/3/79				7/31/79				8/28/79			
Taxon	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z
Penaeus duorarum	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Callinectes sapidus	4	0	1	0	4	0	0	0	0	0	0	1	1	0	0	0	2	1	1	0	0	1	0	0	0	0	1	1
Menippe mercenaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harengula jaguana	0	0	0	0	0	0	0	0	388	138	0	0	0	0	0	0	0	0	0	0	2	0	0	0	38	22	0	0
Anchoa mitchilli	1	0	0	0	3	0	0	0	0	0	7	0	13	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Menidia beryllina	168	43	37	1	69	14	111	0	396	64	341	1	6	0	19	5	1	4	12	3	8	1	183	239	531	25	311	8
Bairdiella chrysoura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cynoscion nebulosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pogonias cromis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	173	43	38	1	76	14	112	0	784	202	348	2	20	0	65	6	3	5	13	3	10	2	186	239	569	47	312	9

Note: See abbreviation and footnote at end of table.

Table 5-82. Abundance of RIS taxa (invertebrates and fish) reported from seine collections made at four stations near Big Bend from March 1979 to January 1980[a] (Sheet 2 of 2)

	Collection date by station																				
	9/25/79				10/23/79				11/20/79				12/18/79				1/15/80				
Taxon	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	W	X	Y	Z	Total
Penaeus duorarum	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	6
Callinectes sapidus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	20
Menippe mercenaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harengula jaguana	32	32	0	23	80	13	4	3	40	3	0	44	0	0	0	0	0	0	0	0	862
Anchoa mitchilli	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
Menidia beryllina	165	120	38	48	1020	2	337	6	250	2	4	102	555	48	0	123	150	68	21	1	5661
Bairdiella chrysoura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cynoscion nebulosus	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pogonias cromis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46
Total	197	152	38	71	1101	15	343	9	291	5	4	146	555	48	0	123	150	69	21	1	6621

Abbreviation: RIS = representative important species.

[a] Adapted from Comp (1980).

Table 5-83. Abundance of RIS taxa (invertebrates and fish) reported from trawl collections made at five stations near Big Bend from March 1979 to January 1980[a] (Sheet 1 of 3)

	Collection date by station																								
	3/14/79					4/10/79					5/10/79					6/5/79					7/3/79				
Taxon	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Penaeus duorarum	2	0	8	6	18	29	13	17	10	6	5	6	2	4	3	0	11	0	0	2	5	0	18	4	10
Callinectes sapidus	2	0	3	1	2	18	4	0	13	7	1	4	1	0	0	0	0	3	3	0	0	0	0	0	2
Menippe mercenaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harengula jaguana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anchoa mitchilli	6	0	10	8	3	0	0	3	2	3	3	4	6	0	2	1	19	8	0	0	1	0	0	1	5
Menidia beryllina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bairdiella chrysoura	0	0	4	0	0	0	5	0	0	1	6	958	1	0	2	6	662	3	0	2	3	0	1	0	0
Cynoscion nebulosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pogonias cromis	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	3	0	0	0	2	1	0	0	0
Total	10	0	25	15	23	47	22	20	25	17	15	975	10	4	7	8	695	14	3	4	11	1	19	5	17

Note: See abbreviation and footnote at end of table.

Table 5-83. Abundance of RIS taxa (invertebrates and fish) reported from trawl collections made at five stations near Big Bend from March 1979 to January 1980[a] (Sheet 2 of 3)

Taxon	Collection date by station																								
	7/31/79					8/28/79					9/25/79					10/23/79					11/20/79				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Penaeus duorarum	11	3	31	0	10	56	3	45	0	5	16	9	28	3	16	2	106	61	25	26	34	63	27	11	7
Callinectes sapidus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	3	0	0	0
Menippe mercenaria	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Harengula jaguana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anchoa mitchilli	2	5	6	5	2	4	0	4	0	2	8	0	3	6	8	18	3	3	3	1	131	8	1	2	6
Menidia beryllina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bairdiella chrysoura	0	0	1	1	0	1	0	1	0	1	1	2	1	0	0	6	5	1	9	0	2	2	4	0	2
Cynoscion nebulosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pogonias cromis	0	0	0	0	0	0	8	0	0	0	1	9	0	0	0	2	10	0	0	0	0	6	0	0	0
Total	13	8	38	6	12	61	11	50	0	8	26	20	32	9	24	29	124	66	37	27	167	82	32	13	15

Note: See abbreviation and footnote at end of table.

Table 5-83. Abundance of RIS taxa (invertebrates and fish) reported from trawl collections made at five stations near Big Bend from March 1979 to January 1980[a] (Sheet 3 of 3)

Taxon	Collection date by station										
	12/18/79					1/15/80					
	A	B	C	D	E	A	B	C	D	E	Total
Penaeus duorarum	50	6	33	19	14	13	6	23	13	3	957
Callinectes sapidus	0	3	1	6	0	2	2	0	3	0	86
Menippe mercenaria	0	0	1	0	0	0	0	0	0	0	1
Harengula jaguana	0	0	0	0	1	0	0	0	0	1	2
Anchoa mitchilli	44	0	1	1	0	19	0	14	78	7	480
Menidia beryllina	0	0	0	0	0	0	0	0	0	0	0
Bairdiella chrysoura	10	1	1	0	0	1	1	0	0	3	1,711
Cynoscion nebulosus	0	0	0	0	0	0	0	0	0	0	0
Pogonias cromis	1	5	0	0	0	0	3	0	0	0	55
Total	105	15	37	26	15	35	12	37	94	14	3,292

Abbreviation: RIS = representative important species.

[a] Adapted from Comp (1980).

Table 5-84. Non-RIS macroinvertebrate taxa reported from
Big Bend seine, trawl, and impingement collections
made from March 1979 to February 1980[a] (Sheet 1 of 2)

Taxon	Collections		
	Seine	Trawl	Impingement
Aurelia aurita Moon jelly			X
Chrysaora quinquecirrha Sea nettle			X
Polinices duplicatus Moon snail		X	
Busycon contrarium Lightning whelk		X	
Melongena corona Crown conch	X	X	
Fasciolaria illium hunteria Banded tulip		X	
Oliva sayana Lettered olive		X	
Lollinguncula brevis Brief squid	X	X	X
Limulus polyphemus Horseshoe crab	X	X	X
Squilla empusa Mantis shrimp		X	X
Trachypenaeus constrictus Penaeid shrimp		X	X
Palemonetes pugio Grass shrimp	X	X	X
Pagurus longicarpus Hermit crab	X	X	
Pagurus pollicaris Hermit crab	X	X	
Pagurus sp. Hermit crab	X	X	
Hapatus pudibundus		X	
Persephona aquilonaris Purse crab		X	
Portunus gibbesii Portunid crab	X	X	X
Hexanopeus angustifrons Xanthid crab			X
Hexanopeus sp. Xanthid crab			X
Neopanope texana Xanthid crab		X	X
Eurypanopeus depressus Xanthid crab	X	X	X

Note: See abbreviation and footnote at end of table.

Table 5-84. Non-RIS macroinvertebrate taxa reported from Big Bend seine, trawl, and impingement collections made from March 1979 to February 1980[a] (Sheet 2 of 2)

Taxon	Collections		
	Seine	Trawl	Impingement
Panopeus herbstii Xanthid crab			X
Unidentified xanthid Xanthid crab		X	X
Sesarma cinerium Friendly crab			X
Sesarma sp.			X
Pinnixa chaetopterana Commensal crab		X	
Libinia dubia Spider crab		X	X
Luidia clathrata Sea star		X	
Molgula sp. Tunicate		X	X

Abbreviation: RIS = representative important species.

[a] Adapted from Comp (1980).

Table 5-85. Benthic invertebrate taxa reported from collections made at Big Bend from February 1976 to February 1977[a] (Sheet 1 of 4)

- Porifera
  - Unidentified sp.
- Cnidaria
  - Hydrozoa
    - Campanularidae
    - Clavidae
    - Eudendridae
    - Unidentified sp.
  - Anthozoa
    - Alcyonaridae
    - *Edwardsia* sp.
    - Unidentified sp.
    - Unidentified sp. (Anemone)
- Platyhelminthes
  - *Euplana gracilis*
  - *Stylochus* sp.
  - Unidentified sp.
- Nemertinea
  - Unidentified sp.
- Nematoda
  - Unidentified sp.
- Annelida
  - Oligochaeta
    - Unidentified sp.
  - Polychaeta
    - *Aglaophamus verrilli*
    - *Ameana trilobata*
    - Ampharetidae (juv.)
    - *Amphicteis gunneri*
    - *Ancistrosyllis jonesi*
    - *Apoprionospio pygmaea*
    - *Arenicola cristata*
    - *Aricidea* sp.
    - *Asychis* sp.
    - *Autolytus* sp.
    - *Branchioasychis americana*
    - *Brania clavatum*
    - *Brania* sp.
    - *Cabira inserta*
    - *Capitella capitata*
    - *Capitella* (juv.)
    - *Caulleriella* sp.
    - *Chaetopterus variopedatus*
    - *Chaetozone setosa*
    - *Chone* sp.
    - Cirratulidae (juv.)
    - *Cirriformia grandis*

- Polychaeta (continued)
  - *Cirratulus* sp.
  - *Cirrophorus* sp.
  - *Clymenella mucosa*
  - *Clymenella torquata* calida
  - *Ctenodrilus* sp.
  - *Ctenodrilus serratus*
  - *Diopatra cuprea*
  - *Drilonereis longa*
  - *Drilonereis* sp.
  - *Eteone heteropoda*
  - *Eumida sanguinea*
  - *Eunice* sp.
  - *Exogune* sp.
  - *Fabricia sabella*
  - *Glycera americana*
  - *Glycinde solitaria*
  - *Gyptis vittata*
  - *Harmothoe* sp.
  - *Hesione picta*
  - *Hypsicomus phaeotaenia*
  - *Isolda pulchella*
  - *Laeonereis culveri*
  - *Lumbrineris coccinea*
  - *Lumbrineris* sp.
  - *Magelona pettiboneae*
  - *Maldane sarsi*
  - Maldanidae (juv.)
  - *Malacoceros* sp. (*glutaeus* ?)
  - *Marphysa sanguinea*
  - *Mediomastus californiensis*
  - *Megalomma bioculatum*
  - *Melinna maculata*
  - *Melinnopsis atlantica*
  - *Mesochaetopterus* sp.
  - *Minuspio cirrifera*
  - *Minuspio* sp.
  - *Naineris* near *laevigata*
  - *Naineris* sp.
  - *Nereidae* unidentified sp.
  - *Nereis succinea*
  - *Notomastus hemipodus*
  - *Notomastus latericeus*
  - *Odontosyllis* sp.
  - *Onuphis* sp.
  - *Ophryotrocha puerilis*
  - Orbiniidae (juv.)

Note: See footnote at end of table.

Table 5-85. Benthic invertebrate taxa reported from collections made at Big Bend from February 1976 to February 1977[a] (Sheet 2 of 4)

Polychaeta (continued)
Paraprionospio pinnata
Parahesione luteola
Pectinaria gouldii
Pherusa arenosa
Phyllodoce arenosa
Phyllodoce fragilis
Phyllodocidae
Phylo ornatus
Philarigidae (juv.)
Piromis (pherusa) eruca
Pista cristata
Pista palmata
Podarke obscura
Poecilochaetus johnsoni
Polycirrus eximius
Polydora ligni
Polydora socialis
Polydora sp.
Polynoidae sp.
Prionospio heterobranchia
Pseudeurythoe ambigua
Pseudopolydora sp. A
Pseudopolydora sp. B
Schistomeringos longicornus
Scolelepis sp.
Scoloplos foliosus
Scoloplos robustus
Scoloplos rubra
Scoloplos sp. (juv.)
Sigambra tentaculata
Spio pettiboneae
Spiochaetopterus costarum oculatus
Spionidae (juv.)
Spionidae unidentified sp. A
Stenoninereis martini
Sthenelais boa
Streblospio benedicti
Syllis gracilis
Syllis sp.
Terebellidae (juv.)
Terebella rubra
Terebella sp.
Travisia hobsonae
Tharyx sp.
Typosyllis sp.

Mollusca
Bivalvia
Abra aequalis
Amygdalum papyrium
Anadara transversa
Brachiodontes exustus
Corbula contracta
Corbula swiftiana
Corbula sp. (juv.)
Crassinella lunulata
Crassostrea virginica
Cyclinella tenuis
Cyrtopleura costata
Dosinia discus
Ensis directus
Ischadium recurvum (juv.)
Laevicardium mortoni
Montacuta sp.
Parvilucina multilineata
Lyonsia hyalina floridana
Macoma tenta
Mercenaria campechiensis (juv.)
Modiolus sp.
Mulinia lateralis
Musculus lateralis
Nucula crenulata
Ostrea equestris
Parastarte triquetra
Cyrenoida florida
Semele profica
Sphenia antillensis
Tagelus divisus
Tagelus plebius
Tellina lineata
Tellina versicolor
Mysella planulata
Semele purpurascens
Gastropoda
Acteocina canaliculata
Acteon Punctostriatus
Acteon sp.
Anachis obesa
Caecum pulchellum
Caecum sp.
Circulus suppressus
Crepidula plana
Cyclostremiscus sp.
Doridacea

Note: See footnote at end of table.

Table 5-85. Benthic invertebrate taxa reported from collections made at Big Bend from February 1976 to February 1977[a] (Sheet 3 of 4)

- Gastropoda (continued)
  - *Doto* sp.
  - *Elysia* sp.
  - *Epitonium angulatum*
  - *Epitonium foliaceicostum*
  - *Epitonium humphreysi*
  - *Epitonium rupicola*
  - *Epitonium* sp.
  - *Eupleura sulcidentata*
  - *Haminoea succinea*
  - *Melanella* sp.
  - *Melongena corona*
  - *Mitrella lunata*
  - Muricidae
  - *Nassarius Vibex*
  - *Natica* sp.
  - *Natica pusilla*
  - Nudibranchia (unidentified sp.)
  - *Odostomia* sp.
  - *Odostomia impressa*
  - *Oliva sayana*
  - *Olivella perplexa*
  - *Polinices duplicatus*
  - *Prunum apicinum*
  - *Pyramidella* sp.
  - *Sinum perspectivum*
  - *Spurilla* sp.
  - *Strombiformis hemphilli*
  - *Teinostoma* sp.
  - *Terebra* sp.
  - *Triphora* sp.
  - Trophoninae
  - *Turbonilla conradi*
  - *Turbonilla hemphilli*
  - *Turbonilla* sp.
  - *Urosalpinx* sp.
  - Vitrinellidae
- Arthropoda
  - Xiphosura
    - *Limulus polyphemus*
  - Pycnogonida
    - Unidentified sp.
  - Amphipoda
    - *Acanthohaustorius* sp. (*millsi* grp.)
    - *Ampelisca abdita*
    - *Ampelisca holmesi*
    - *Argissa* sp.
    - *Batea catharinensis*
  - Amphipoda (continued)
    - Caprellidae
    - *Cerapus* sp.
    - *Corophium* sp. (*lacustre* grp.)
    - *Corophium* sp. (*louisianum* grp.)
    - *Corophium* sp. (*acherusicum* grp.)
    - *Cymadusa* sp.
    - *Elasmopus levis*
    - *Erichthonius*, near *brasiliensis*
    - *Gammarus mucronatus*
    - *Gitanopsis* sp.
    - *Grandidierella bonnieroides*
    - *Lembos smithi*
    - *Lembos* sp.
    - *Lembos* near *websteri*
    - *Leucothoe* sp.
    - *Listriella*, near *barnardi*
    - *Lysianopsis alba*
    - *Melita appendiculata*
    - *Melita nitida*
    - *Melita* n. sp.
    - *Microdeutopus* sp.
    - *Monoculodes nyei*
    - *Monoculodes* sp. (*Edwardsi* grp.)
    - N. gen. n. sp., near *platyishnopus*
    - *Parametopella cypris*
    - *Paraphoxus*, near *spinosus*
    - *Photis pugnator*
    - *Podocerus* sp.
    - *Rudilemboides naglei*
    - *Stenothoe* n. sp.
    - *Stenothoe* sp.
    - *Trichophoxus floridanus*
  - Leptostraca
    - *Nebalia* sp.
  - Isopoda
    - *Aegathoa oculata*
    - *Apanthura magnifica*
    - *Cyathura polita*
    - *Cymodoce faxoni*
    - *Edotea montosa*
    - *Erichsonella filiformis*
    - *Munna* sp. (nov.)
    - Sphaeromatidae (juv.)
    - *Sphaeroma quadridentatum*
    - *Xenanthura brevitelson*
    - Unidentified sp. A

Note: See footnote at end of table.

Table 5-85. Benthic invertebrate taxa reported from collections made at Big Bend from February 1976 to February 1977[a] (Sheet 4 of 4)

- Cumacea
  - *Cumella garritii*
  - *Cyclaspis varians*
  - *Cyclaspis* sp.
  - *Leucon acutirostris*
  - *Oxyurostylis smithi*
- Mysidacea
  - *Mysidopsis bigelowi*
- Tanaidacea
  - Unidentified sp. A
  - Unidentified sp. B
- Ostracoda
  - *Haplocytherida setipunctata*
  - *Parasterope pollex*
  - *Sarsiella tricostata*
  - *Sarsiella zostericola*
  - *Sarsiella* sp.
  - Unidentified sp. A
- Copepoda
  - *Temora* sp.
  - Unidentified sp.
- Notodelphyoida
  - Unidentified sp.
- Cirripedia
  - *Balanus* sp.
- Stomatopoda
  - *Squilla empusa*
- Decapoda
  - *Alpheus heterochaelis*
  - *Callinectes sapidus*
  - *Euceramus praelongus*
  - *Eurypanopeus depressus*
  - *Hexapanopeus angustifrons*
  - Grapsiidae
  - *Latreutes parvulus*
  - *Leptochela* sp.
  - *Leptodius* sp.
  - *Lucifer faxoni*
  - *Menippe mercenaria*
  - Majiidae
  - *Neopanope texana texana*
  - *Ogyrides limicola*
  - *Pagurus annulipes*
  - *Pagurus longicarpus*
  - Palaemonidae
  - *Paleomonetes* sp.
  - *Panopeus herbtii*
  - *Penaeus duorarum*
- Decapoda (continued)
  - Penaeidae
  - *Periclimenes americanus*
  - *Persephona* sp.
  - *Petrolisthes galathinus*
  - *Pinnixa* sp.
  - *Pinnotheres* sp.
  - *Polyonx gibbesi*
  - Porcellanidae
  - *Ambidexter* sp.
  - *Tozuema carolinense*
  - *Trachypeneus constrictus*
  - *Upogebia* sp.
  - Unidentified shrimp
  - Unidentified sp. xanthid crab
- Phoronida
  - *Phoronis architecta*
  - *Phoronis* sp.
- Bryozoa
  - *Bugula* sp.
  - *Electra* sp.
  - Unidentified sp.
- Brachiopoda
  - *Glottidia pyramidata*
- Echinodermata
  - Ophiuroidea
    - *Amphioplus abditus*
    - *Amphioplus thrombodes*
    - *Amphipholis atra*
    - *Amphipholis gracillima*
    - *Amphipholis squamata*
    - *Hermipholis elongata*
    - *Ophiophragmus filograneus*
    - Unidentified sp.
  - Holothuroidea
    - *Leptosynapta* sp.
    - Unidentified sp.
- Hemichordata
  - Unidentified sp.
- Chordata
  - Urochordata
    - *Bostrichobranchus pilularis*
    - *Molgula* sp.
    - *Styela plicata*
    - Unidentified sp. (juv.)
  - Cephalochordata
    - *Branchiostoma caribaeum*

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[a] Adapted from Mahadevan et al. (1977).

Table 5-86. The nine most abundant benthic invertebrate taxa (in order of decreasing abundance) reported from collections made at Big Bend from February 1976 to February 1977[a]

Mysella planulata (bivalve mollusk)
Ampelisca abdita (amphipod)
Parasterope pollex (ostracod)
Mulinia lateralis (bivalve mollusk)
Haplocytherida setipunctata (ostracod)
Pseudopolydora sp. (polychate)
Ampelisca holmesi (amphipod)
Cyclaspis varians (cumacean)
Rudilemboides naglei (amphipod)

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[a] Adapted from Mahadevan et al. (1977).

Table 5-87. Benthic invertebrate taxa reported from collections made at Big Bend from May to December 1979[a] (Sheet 1 of 2)

- Porifera
- Cnidaria
  - Hydrozoa
  - Anthozoa
    - Unidentified sp. (Anemone)
- Platyhelminthes
  - *Euplana gracilis*
  - *Stylochus* sp.
  - *Polycladida* sp. A
  - *Polycladida* sp. B
- Nemertinea
  - Unidentified sp. (Nemertinea)
- Nematoda
  - Unidentified sp. (Nematoda)
- Annelida
  - Piscicolidae sp.
  - Oligochaeta
    - Unidentified sp.
  - Polychaeta
    - *Apoprionospio pygmaea*
    - *Brania* sp.
    - *Capitella capitata*
    - *Chone* sp.
    - *Diopatra cuprea*
    - *Eteone heteropoda*
    - *Glycera americana*
    - *Glycinde solitaria*
    - *Gyptis vittata*
    - *Mediomastus californiensis*
    - *Nereis succinea*
    - *Onuphis* sp.
    - *Parahesione luteola*
    - *Paraprionospio pinnata*
    - *Pectinaria gouldii*
    - *Phyllodoce arenae*
    - *Phyllodoce fragilis*
    - *Pista palnata*
    - *Polydora ligni*
    - *Polydora socialis*
    - *Polydora* sp.
    - *Schistomeringos longicornus*
    - *Scoloplos foliosus*
    - *Scoloplos rubra*
    - Spionidae unidentified sp. A
    - *Steninonereis martini*
    - *Streblospio benedicti*
    - *Tharyx* sp.
- Mollusca
  - Bivalvia
    - *Amygdalum papyrium*
    - *Crassostrea virginica*
    - *Cyrtopleura costata*
    - *Ensis minor*
    - *Macoma tenta*
    - *Chione cancellata*
    - *Mulinia lateralis*
    - *Sphenia antillensis*
    - *Tagelus plebius*
    - *Tellina versicolor*
    - *Mysella* sp.
    - Veneridae sp.
    - *Mytilopsis leucophaeata*
    - *Myoida* spat (*Hiatella*)
  - Gastropoda
    - *Acteocina canaliculata*
    - *Acteon punctostriatus*
    - *Crepidula plana*
    - *Haminoea succinea*
    - *Mitrella lunata*
    - *Odostonia* c.f. *conoidae*
- Arthropoda
  - Xiphosura
  - Pycnogonida
    - *Anaplodactylus pygmaeus*
  - Amphipoda
    - *Ampelisca abdita*
    - *Ampelisca holmesi*
    - Caprellidae *Aeginella* sp.
    - *Corophium* sp. (*acherusicum* grp.)
    - *Erichthonius*, near *brasiliensis*
    - *Grandidierella bonnieroides*
    - *Listriella*, near *barnardi*
    - *Podocerus* sp.
    - *Stenothoe* sp.
    - Unidentified sp.
  - Leptostraca
  - Isopoda
    - *Sphaeroma quadridentatum*
  - Cumacea
    - *Cyclaspis varians*
    - *Oxyurostylis smithi*
  - Mysidacea
    - *Mysidopsis bigelowi*
    - *Bowmaniella dissimilis*
  - Tanaidacea
  - Ostracoda

Note: See footnote at end of table.

Table 5-87. Benthic invertebrate taxa reported from collections made at Big Bend from May to December 1979[a] (Sheet 2 of 2)

- Copepoda
    - *Temora* sp.
    - *Brachiodontes exustus*
- Notodelphyoida
- Cirripedia
    - *Balanus* sp.
- Stomotapoda
- Decapoda
    - *Callianassa* sp.
  - Grapsiidae
    - *Leptochela* sp.
    - *Ogyrides limicola*
    - *Pagurus* sp. (juv.)
    - *Panopeus herbstii*
    - *Pinnixa* sp.
    - *Upogebia* sp.
    - Unidentified sp. xanthid crab
- Phoronida
- Bryozoa
- Brachiopoda
- Echinodermata
  - Ophiuroidea
    - *Ophiophragmus filograneus*
  - Molothuroidea
    - Unidentified sp. (Holothuroidea)
- Hemichordata
- Chordata
  - Urochordata
  - Sipunculida
  - Cephalochordata
    - *Branchiostoma caribaeum*
- Chaetognatha

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[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-88. Temporal and spatial distribution of the dominant benthic invertebrate taxa collected at Big Bend from May to December 1979[a] (Sheet 1 of 2)

Sampling date	Station													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
May 11	S.b. C.v. N.s.	S.b. C.v. C.p.	A.h. C.v. O.s.	M.c. C.v. G.s.	M.c. G.s. C.v.	C.v. G.s.	M.c. N.	M.c. A.a. C.v	M.c. G.s. C.v.	M.c. H. A.p.	M.c. G.s. Ne.	N. G.s. Pa.p.	N. H. P.sp. Mi.c.	A.h. A.a. C.sp.
June 21, 22	N.s. S.m.	B.sp. S.a. P.l.	C.c. P.sp. N.s.	P.A. G.s. A.h.	P.A. Pa.p. Mi.c.	M.c. N. Pa.p.	Pa.p. P.A. Mi.c.	A.a. M.p. Pa.p.	N. A.a. M.c.	Pa.p. M.c. N.	M.c. Pa.p. P.A.	P.A. N. Pa.p.	P.A. N. Mi.c.	A.h. A.a. H.s.
August 2	N.s. Pa.p.	N.s. B.c.	N.s. Ha.s. C.c.	P.A. G.s. A.a.	P.A. P.p. Pi.s.	N. P.A. H. Pa.p.	M.c. S.g. S.a.	S.r. Pi. Pa.p.	N. Pa.p. G.s.	Pa.p S.r. M.c.	Pa.p. M.c.	Pa.p. P.A. N.	N. Pa.p. Pi.s.	A.h. H.s.
August 24	B. N.s.	S.m. P.s. Pa.p.	C.c. N.s. P.s.	M.c. Pa.p.	N. Pa.p.	G.v. Pa.p.	P.A. Pi.s. M.c.	Pa.p. N. A.a.	Pa.p. O.c. Og.	Pa.p. N. Og. S.r.	Pa.p. T.sp.	P.A. N. Mi.c.	Pa.p. P.A. Pi.s.	N. H.s.
September 19	N.s. S.b. M.l.	S.b. Pa.p. N.s.	N.s. C.c. Ha.s.	M.c. Pa.p. G.s.	S.b.	O.c. N. P.A.	N. Pa.p M.c.	Pa.p. O.c. M.c.	Pa.p. M.c	M.c. Pa.p. Og.	T.sp. Pa.p. M.c.	P.A. N. Mi.c.	P.A. Mi.c. Pa.p.	C.c. S.b.
November 1	N.s. S.b. S.m.	S.m.	N.s. Ha.s. V.sp.	M.c. Pa.p. G.s.	Pa.p. G.s.	S.b. Pa.p. N.s.	Og. Pa.p.	Pa.p. E.w. G.s.	M.c. Pa.p. S.b.	M.c. S.b. Pa.p.	Pa.p. G.s. M.c.	Pa.p. S.b. G.s.	S.b. Pa.p.	L.c. Ha.s. E.h. C.c.

Note: See abbreviations and footnote at end of table.

Table 5-88. Temporal and spatial distribution of the dominant benthic invertebrate taxa collected at Big Bend from May to December 1979[a] (Sheet 2 of 2)

Sampling date	Station													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
December 13	M.l. T.v. S.b.	S.m. S.b. M.l.	Ha.s. M.l.	M.l. M.c.	M.c. M.l. Pa.p.	M.l. N.s.	M.c. M.l.	M.l. M.c. P.g.	M.l. M.c.	M.l. M.c. O.c.	M.l. M.c. O.c.	M.l. Pa.p. P.g.	M.l. M.c.	Ha.s. On.sp. M.l.

Abbreviations:

A.a. = *Ampelisca abdita*.
A.h. = *Ampelisca holmesi*.
A.p. = *Apoprinospio pygmaea*.
B. = Bivalvia.
B.c. = *Branchiostoma caribaeum*.
B.sp. = *Balanus* species.
C.c. = *Capitella capitata*.
C.p. = *Crepidula plana*.
C.sp. = *Corophium* species.
C.v. = *Cyclaspis varians*.
E.h. = *Eteone heteropoda*.
E.w. = *Eulimastoma* c.f. *weberi*.
G.s. = *Glycinde solitaria*.
H. = Hemichordata.
Ha.s. = *Haminoea succinea*.
H.s. = *Haplocytherida setipunctata*.
L.c. = *Laeonereis culveri*.
M.c. = *Mediomastus californiensis*.
Mi.c. = *Minuspio cirrifera*.
M.l. = *Mulinia lateralis*.
M.p. = *Mysella planulata*.
N. = Nematoda.
Ne. = Nemertina.
N.s. = *Nereis succinea*.
O.c. = *Odostomia* c.f. *conoidea*.
Og. = Oligochaeta.
On.sp. = *Onuphis* species.
O.s. = *Oxyurostylis smithi*.
P.A. = *Pseudopolydora* sp. A.
P.g. = *Pectinaria gouldii*.
Pi. = *Pinnixa*.
P.l. = *Polydora ligni*.
Pa.p. = *Paraprionospio pinnata*.
Pi.s. = *Pinnixa sayana*.
P.s. = *Polydora socialis*.
P.sp. = *Polydora* species.
S.a. = *Sphenia antillensis*.
S.b. = *Streblospio benedicti*.
S.g. = *Syllis gracilis*.
S.m. = *Stenoninereis martini*.
S.r. = *Scoloplos rubra*.
T.sp. = *Tharyx* species.
T.v. = *Tellina versicolor*.
V.sp. = Veneridae species.

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-89. Comparison of the temporal and spatial distribution of the dominant benthic invertebrates collected at comparable stations near Big Bend during 1979 and 1976[a]

Station 79/76	May		June		August			September		November		December		Most dominant (≥3) sampling periods	
	79	76	79	76	3-79	24-79	76	79	76	79	76	79	76	79	76
1/11	S.b. C.v.	Mu.l. C.c. C.v. N.s.	N.s. S.m.	C.v. N.s. C.c.	N.s. Pa.p.	N.s. M.H.	N.s.	Mu.l. N.s. S.b.	N.s. M.s.	N.s. S.b. S.m.	M.s.	Mu.l.	M.s. Mu.l. N.s.	N.s. S.b.	N.s. M.p.
2/116	S.b. C.v. A.d.	A.s. N.s.	B.s.	A.s. P.A. C.v.	N.s. N. B.c.	S.m. P.p. P.s.	N.s. M.s. A.s.	S.b. Pa.p.	A.s.	S.m.	A.s. C.s.	Mu.l. S.b. S.m.	P. C.s. A.s.	S.b. S.m.	A.s.
3-	C.v. O.s. A.h.	NCD	N.s. C.c. P.s. A.h.	NCD	N.s. C.c. N.s.	C.c. N.s. P.s.	NCD	H.s. C.c. N.s.	NCD	H.s. T.s. N.s.	NCD	N.s. Mu.l.	NCD	N.s. H.s. C.c.	
4/BC8	C.v. M.c.	P.p. R.n.	G.s. P.A.	P.p.	P.A.	M.c. Pa.p. O.	M.s.	M.c. Pa.p. O.	M.s. C.v.	Pa.p. M.c. G.s.	M.s. A.h.	Mu.l. M.c.	M.s.	M.c. Pa.p.	M.p.
5/BC7	C.v. G.s. M.c.	C.v. P.A.	P.A. Pa.p.	P.A. N.	Pa.p. P.A. P.say	N. Pa.p. G.v. P.A.	P.A. Pa.p.	S.b. Pa.p.	P.A. Pa.p.	Pa.p.	A.h.	Mu.l.	P.A.	Pa.p. P.A.	P.A.
6/BC6	C.v.	C.v. P.p. Pa.p.	O. N. M.c. Pa.p.	NCD	Pa.p. P.A. N.	G.v. Pa.p. N.	M.s.	Od.c. N. P.A.	NCD	Pa.p. S.b.	P.A. C.s. Er.	Mu.l.	NCD	Pa.p. N.	
7/BC4	M.c.	Cy. P.p. A.h.	Pa.p. N. P.A.	NCD	M.c. P.s. S.g. S.a.	M.c. P.A. N. P.say	Pa.p. M.c.	N. Pa.p. M.c.	NCD	Pa.p. O.	Pa.p. N. T. M.c.	Mu.l. M.c. N.s.	NCD	M.c. Pa.p.	
8-	C.v. A.a. M.s. M.c.	NCD	A.d.	NCD	S.r. Pin. Pa.p.	Pa.p. A.a. N.	NCD	Pa.p. O. M.c.	NCD	Pa.p. G.s. E.w.	NCD	Mu.l. M.c.	NCD	Pa.p. M.c. A.a.	
9-	M.c.	NCD	N. M.c. A.a.	NCD	Pa.p. G.s. N.	Pa.p. Od.c. O.	NCD	Pa.p. M.c.	NCD	Pa.p. M.c. E.w.	NCD	Mu.l. M.c.	NCD	M.c. Pa.p.	
10/E6	M.c.	P.p. Hap. R.n.	Pa.p.	M.s.	S.r. Pa.p.	N. O. Pa.p. S.r.	T. M.s.	Pa.p. O. N. M.c.	M.s.	M.c. S.b. Pa.p. G.s.	T. M.s. P.p. Hap.	Mu.l. M.c.	M.s. Hap.	M.c. Pa.p.	M.p. Hap.
11/E5	M.c. G.s. N.	P.p.	Pa.p. M.c.	C.v. Pa.p.	M.c. Pa.p.	Pa.p. T.	A.h. Pa.p. T.	T. Pa.p.	A.h.	E.w. Pa.p. G.s. M.c.	T.	Mu.l. M.c. Od.s.	T. N. Pa.p.	M.c. Pa.p.	Pa.p. T.
12/E4	N. H.	P.p. M.	Pa.p. N. P.A.	NCD	Pa.p. H. P.A. N.	N. G.v. M. Pa.p. P.A.	M. Pa.p. P.A.	M. N. P.A.	NCD	Pa.p. S.b. G.s. Mu.l.	N. M.	Mu.l. Pa.p.	NCD	Pa.p. P.A.	M.
13/E2	N. H.	P.p. N. S.z.	N. P.A.	NCD	Pa.p. H. N.	G.v. Pa.p. P.A. P.say	Pa.p. M. P.p.	P.A. M.	NCD	S.b.	N. T.	Mu.l. M.c.	NCD	P.A.	
16/117	A.a. A.h.	P.p. Hap.	A.h. A.a. Hap.	NCD	A.h. Hap.	N. Hap.	Hap. H.s. A.	C.c. S.b.	NCD	H.s. L.c.	Hap. A.h. C.v.	On. Mu.l. H.s.	NCD	A.h. Hap.	Hap.

Abbreviations:

A. = Aricidea sp.
A.a. = Ampelisca abdita.
A.h. = Ampelisca holmes.
A.p. = Apoprinospio pygmaea.
A.s. = Anemone sp.
B.c. = Branchiostoma caribaeum.
B.s. = Balanus sp.
C.c. = Capitella capitata
C.s. = Caprellida sp.
C.v. = Cyclaspis varians.
C.y. = Cyclaspis sp.
E.r. = Erichthonius c.f brasiliensis.
E.w. = Eulimastoma c.f. weberi.
G.s. = Glycinde solitaria.
G.v. = Gyptis vittata.
H. = Hemichordata sp.

Hap. = Haplocytherida setipunctata.
H.s. = Haminoea succinea.
L.c. = Laeonereis culveri.
M. = Minuspio cirrifera.
M.c. = Mediomastus californiensis.
Mu.l. = Mulinia.
M.H. = Myoida (Hiatella).
M.l. = Mytilopsis leucophaeata.
M.s. = Mysella sp.
N. = Nematoda sp.
N.s. = Nereis succinea.
O. = Oligochaeta sp.
O.d.c. = Odostomia c.f. conoidea.
On. = Onuphis sp.
O.s. = Oxyurostylis smithi.
P. = Podocerus sp.

P.A. = Pseudopolydora sp. A.
Pa.p. = Paraprionospio pinnata.
Pin. = Pinnixa sp.
P.say = Pinnixa sayana.
P.p. = Parasterope pollex.
P.s. = Polydora socialis.
R.n. = Rudilemboides naglei.
S.a. = Sphenia antillensis.
S.b. = Streblospio benedicti.
S.g. = Syllis gracilis.
S.m. = Stenoninereis martini.
S.r. = Scoloplos rubra.
S.z. = Sarsiella zostericola.
T. = Tharyx sp.
T.s. = Tellina sp.
NCD = no comparable data.

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-90. Relative abundance and density of *Nereis succinea* collected at stations near Big Bend from May to December 1979[a],[b]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	3(1,371)	52(1,598)	51(561)	44(417)	34(3,174)	52(3,939)	3(136)	34(1,599)	22(1,450)	65(91)
2	5(583)	0(00)	45(341)	1(8)	3(273)	0(00)	6(76)	9(183)	16(224)	189(123)
3	1(23)	11(288)	31(727)	25(379)	30(311)	27(917)	1(45)	18(384)	13(332)	74(86)
4	1(83)	1(8)	2(38)	1(15)	1(15)	1(30)	1(30)	1(16)	1(23)	33(143)
5	1(53)	1(38)	0(00)	0(00)	2(8)	8(205)	1(76)	2(54)	3(72)	150(133)
6	4(83)	1(8)	0(00)	0(00)	0(00)	10(129)	7(280)	3(71)	4(105)	128(147)
7	3(152)	0(00)	5(523)	0(00)	0(00)	2(45)	10(667)	3(198)	4(280)	128(141)
8	1(121)	5(462)	5(174)	1(8)	1(15)	2(68)	1(23)	2(124)	2(161)	83(129)
9	1(15)	0(00)	1(15)	0(00)	1(8)	0(00)	0(00)	1(5)	1(7)	125(132)
10	1(23)	1(30)	2(45)	0(00)	0(00)	1(23)	0(00)	1(17)	1(18)	106(103)
11	1(23)	0(00)	1(30)	0(00)	0(00)	2(76)	1(15)	1(21)	1(27)	106(133)
12	1(15)	0(00)	1(30)	0(00)	1(15)	7(106)	3(83)	2(36)	2(42)	133(118)
13	1(15)	0(00)	1(15)	0(00)	1(23)	4(38)	2(76)	1(24)	1(27)	107(111)
14	1(15)	0(00)	1(15)	1(8)	7(167)	6(159)	1(15)	2(54)	3(75)	116(138)

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

[b] Number outside parentheses represents relative abundance (i.e., the percentage of total benthic invertebrate density). Number inside parentheses represents density (i.e., the quantity of organisms per square meter).

Table 5-91. Relative abundance and density of Streblospio benedicti collected at stations near Big Bend from May to December 1979[a,b]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	70(32,765)	1(30)	0(00)	0(00)	29(2,720)	22(1,682)	6(250)	18(5,350)	25(12,135)	139.8(227.8)
2	21(2,492)	0(00)	0(00)	4(53)	74(6,076)	1(8)	17(205)	17(1,262)	27(2,310)	159.6(183.1)
3	0(00)	0(00)	0(00)	0(00)	2(23)	1(30)	0(00)	1(8)	1(13)	183.6(172.9)
4	1(152)	0(00)	0(00)	0(00)	1(15)	8(167)	0(00)	1(48)	3(77)	205.5(160.7)
5	1(136)	0(00)	0(00)	0(00)	55(197)	8(220)	1(53)	9(87)	20(97)	219.3(111.6)
6	1(15)	0(00)	0(00)	1(8)	2(15)	57(750)	1(38)	9(118)	21(279)	239.8(236.4)
7	1(30)	0(00)	0(00)	0(00)	1(8)	5(91)	3(205)	1(48)	2(77)	133.2(160.8)
8	3(682)	1(53)	0(00)	3(30)	7(205)	8(318)	1(76)	3(195)	3(242)	94.1(124.3)
9	2(144)	0(00)	0(00)	0(00)	4(53)	10(538)	1(53)	2(113)	4(195)	150.1(172.8)
10	1(23)	0(00)	0(00)	0(00)	3(76)	18(689)	1(30)	3(117)	7(254)	200.1(217.1)
11	1(76)	0(00)	0(00)	0(00)	1(30)	1(61)	1(8)	1(25)	1(32)	93.5(127.4)
12	0(00)	0(00)	0(00)	0(00)	1(15)	21(318)	1(23)	3(51)	8(118)	238.2(232.3)
13	1(15)	0(00)	0(00)	0(00)	1(8)	71(727)	6(182)	11(133)	26(270)	234.1(202.9)
14	1(15)	0(00)	0(00)	2(23)	14(333)	8(227)	1(23)	4(89)	5(135)	143.1(151.7)

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

[b] Number outside parentheses represents relative abundance (i.e., the percentage of total benthic invertebrate density). Number inside parentheses represents density (i.e., the quantity of organisms per square meter).

Table 5-92. Relative abundance and density of *Mulinia lateralis* collected at stations near Big Bend from May to December 1979[a,b]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	1(152)	1(8)	0(00)	0(00)	16(1,508)	1(30)	51(2,205)	10(558)	19(911)	189.7(1,635)
2	3(318)	0(00)	1(8)	0(00)	1(61)	0(00)	10(121)	2(37)	4(88)	169.2(235.9)
3	1(15)	0(00)	10(235)	1(8)	0(00)	2(53)	31(1,856)	6(310)	11(687)	177.1(221.9)
4	3(492)	7(250)	1(15)	6(83)	1(8)	4(83)	68(11,144)	13(1,725)	24(4,157)	189.9(240.9)
5	3(280)	2(61)	0(00)	3(23)	9(30)	1(23)	70(4,273)	13(670)	25(1,591)	202.7(237.6)
6	4(83)	6(341)	1(23)	0(00)	0(00)	9(114)	71(2,826)	13(484)	26(1,040)	198.4(214.8)
7	1(68)	2(76)	1(8)	2(38)	3(61)	3(61)	13(856)	4(167)	4(305)	118.6(182.6)
8	5(947)	2(242)	1(23)	0(00)	2(45)	3(129)	49(7,508)	9(1,271)	18(2,770)	200.6(218.0)
9	2(144)	2(83)	1(23)	3(53)	6(68)	2(83)	58(7,705)	11(1,166)	21(2,884)	198.4(247.4)
10	1(23)	2(68)	1(8)	1(15)	0(00)	2(76)	52(3,795)	8(569)	19(1,423)	228.1(249.1)
11	0(00)	3(136)	0(00)	2(38)	0(00)	1(15)	38(2,030)	6(317)	14(757)	223.2(238.8)
12	0(00)	1(8)	1(8)	0(00)	1(23)	11(167)	58(1,394)	10(229)	21(517)	208.0(226.4)
13	1(8)	1(8)	1(8)	1(8)	3(98)	6(61)	26(818)	6(144)	9(299)	165.1(207.6)
14	1(136)	3(159)	7(106)	6(91)	5(106)	0(00)	11(962)	5(223)	4(330)	80.0(148.0)

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

[b] Number outside parentheses represents relative abundance (i.e., the percentage of total benthic invertebrate density). Number inside parentheses represents density (i.e., the quantity of organisms per square meter).

Table 5-93. Relative abundance and density of *Mediomastus californiensis* collected at stations near Big Bend from May to December 1979[a,b]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	2(932)	0(00)	0(00)	0(00)	1(8)	0(00)	4(182)	1(160)	2(347)	153(216)
2	1(8)	0(00)	1(8)	0(00)	0(00)	0(00)	1(8)	1(3)	1(4)	125(125)
3	3(159)	1(38)	0(00)	0(00)	0(00)	0(00)	(8)	1(29)	(59)	156(201)
4	57(8,833)	3(98)	4(98)	18(258)	33(523)	22(485)	19(3,152)	22(1,921)	19(3,233)	83(168)
5	42(4,280)	5(182)	1(30)	0(00)	0(00)	0(00)	5(280)	8(682)	15(1,590)	203(233)
6	2(30)	24(1,500)	6(311)	0(00)	3(30)	0(00)	3(136)	5(287)	8(546)	156(191)
7	47(2,795)	2(83)	28(2,788)	10(182)	17(402)	0(00)	37(2,455)	20(1,244)	18(1,353)	89(109)
8	26(5,477)	0(00)	4(129)	0(00)	14(409)	8(326)	18(2,765)	10(1,301)	10(2,085)	98(160)
9	59(5,538)	17(909)	5(76)	3(45)	26(311)	32(1,697)	19(2,523)	23(1,586)	19(1,968)	83(124)
10	53(3,682)	10(303)	9(197)	2(30)	25(576)	23(909)	21(1,508)	20(1,029)	17(1,272)	82(124)
11	54(5,174)	24(1,061)	13(303)	1(15)	8(265)	13(598)	12(659)	18(1,154)	17(1,804)	97(156)
12	5(197)	1(61)	0(00)	1(8)	1(30)	0(00)	4(91)	2(55)	2(71)	115(129)
13	3(235)	1(76)	1(23)	0(00)	1(30)	0(00)	22(697)	4(152)	8(254)	200(168)
14	3(1,561)	1(83)	2(23)	1(8)	0(00)	1(8)	2(90)	1(253)	1(578)	68(228)

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

[b] Number outside parentheses represents relative abundance (i.e., the percentage of total benthic invertebrate density). Number inside parentheses represents density (i.e., the quantity of organisms per square meter).

Table 5-94. Relative abundance and density of *Paraprionospio pinnata* collected at stations near Big Bend from May to December 1979[a,b]

Station	May 11	June 21,22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	1(68)	5(144)	11(121)	0(00)	2(220)	2(144)	1(53)	3(107)	4(73)	121.1(67.7)
2	1(121)	2(144)	0(00)	19(227)	12(955)	1(8)	3(38)	5(213)	7(337)	133.2(158.1)
3	0(00)	2(45)	1(15)	1(8)	5(53)	1(8)	1(8)	2(20)	2(21)	103.0(105.7)
4	1(30)	4(144)	5(114)	13(174)	20(318)	15(347)	1(121)	8(178)	8(114)	89.3(64.2)
5	1(91)	20(727)	20(712)	26(182)	15(53)	49(1,280)	1(61)	19(144)	16(473)	87.0(106.7)
6	1(15)	7(439)	11(530)	21(129)	9(83)	12(159)	2(68)	9(203)	7(199)	75.1(98.0)
7	1(23)	14(621)	2(182)	3(45)	17(409)	23(439)	4(258)	9(282)	9(220)	95.6(77.8)
8	1(61)	5(561)	11(394)	32(371)	23(569)	25(1,023)	3(432)	14(500)	12(297)	86.0(59.3)
9	1(68)	6(295)	10(159)	42(674)	29(341)	15(795)	3(341)	15(382)	15(263)	99.8(68.9)
10	1(91)	12(371)	11(227)	20(280)	18(424)	13(492)	3(242)	11(304)	7(135)	63(44.6)
11	2(159)	14(621)	18(417)	28(439)	17(598)	21(955)	6(295)	15(498)	9(258)	58.4(51.9)
12	8(318)	11(705)	14(462)	10(356)	7(409)	34(508)	10(250)	13(430)	9(149)	69.6(34.7)
13	5(356)	3(545)	16(455)	21(568)	10(379)	9(91)	6(197)	10(370)	6(176)	64.3(47.5)
14	1(21)	1(23)	5(68)	3(38)	3(61)	2(68)	1(121)	2(57)	2(35)	65.5(60.5)

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

[b] Number outside parentheses represents relative abundance (i.e., the percentage of total benthic invertebrate density). Number inside parentheses represents density (i.e., the quantity of organisms per square meter).

Table 5-95. Relative abundance and density of Pseudopolydora sp. collected at stations near Big Bend from May to December 1979[a,b]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)
2	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)
3	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)	0(00)
4	0(00)	23(803)	10(227)	0(00)	1(8)	0(00)	0(00)	5(148)	8.8(300.6)	181(203)
5	0(00)	28(1,045)	28(985)	0(00)	0(00)	0(00)	0(00)	8(290)	13.7(495.6)	171(171)
6	0(00)	0(00)	15(705)	0(00)	11(106)	0(00)	0(00)	4(116)	6.4(262.8)	174(227)
7	0(00)	11(508)	2(61)	32(583)	9(227)	0(00)	0(00)	8(197)	11.6(252.2)	151(128)
8	0(00)	0(00)	0(00)	7(76)	2(53)	0(00)	0(00)	1(18)	2.6(32.2)	204(175)
9	1(68)	9(45)	1(15)	0(00)	0(00)	0(00)	0(00)	2(18)	3.3(27.5)	211(150)
10	1(68)	6(174)	1(30)	1(8)	1(8)	0(00)	0(00)	1(41)	2.1(63.3)	145(154)
11	0(00)	7(333)	3(68)	3(45)	1(15)	0(00)	0(00)	2(66)	2.6(120.7)	129(183)
12	3(121)	33(2,220)	14(439)	21(742)	56(3,326)	0(00)	0(00)	18(978)	20.7(1,294.2)	114(132)
13	1(15)	64(12,470)	14(98)	17(462)	43(1,667)	0(00)	0(00)	20(2,102)	24.7(4,611)	125(219)
14	0(00)	1(8)	0(00)	0(00)	0(00)	0(00)	0(00)	0(1)	0.4(3.0)	265(265)

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

[b] Number outside parentheses relative represents abundance (i.e., the percentage of total benthic invertebrate density). Number inside parentheses represents density (i.e., the quantity of organisms per square meter).

Table 5-96. Abundance (number of individuals per square meter) data for benthic invertebrate collections made at stations near Big Bend from May to December 1979[a]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	45,459	3,030	1,081	926	9,074	7,341	4,252	10,166	15,857	155.97
2	11,526	6,852	2,578	1,185	7,978	496	1,170	4,541	4,258	93.77
3	5,644	2,533	2,304	1,504	1,000	3,289	5,926	3,171	1,931	67.88
4	15,274	3,378	2,141	1,363	1,570	2,119	16,096	5,992	6,657	111.11
5	10,074	3,607	3,459	689	348	2,563	6,000	3,820	3,354	87.79
6	1,867	6,037	4,733	607	948	1,289	3,889	2,767	2,113	76.36
7	5,837	4,452	9,607	1,778	2,363	1,830	6,444	4,616	2,906	62.95
8	20,585	9,926	3,496	1,133	2,793	4,037	14,963	8,133	7,311	89.89
9	9,163	5,170	1,519	1,578	1,156	5,207	12,993	5,255	4,462	84.90
10	6,756	3,059	2,104	1,348	2,289	3,807	7,200	3,795	2,310	60.88
11	9,489	4,393	2,319	1,519	3,363	4,326	5,207	4,373	2,590	58.22
12	3,837	6,504	3,156	3,519	5,822	1,467	2,348	3,808	1,800	47.28
13	6,748	18,993	2,741	2,637	3,748	1,007	3,037	5,559	6,174	110.07
14	53,859	6,104	1,422	1,400	2,267	2,711	8,185	10,850	19,137	176.39

[a]Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-97. Species richness (number of species per station) data for benthic invertebrate collections made at stations near Big Bend from May to December 1979[a]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	62	25	19	7	26	23	33	27.86	17.03	61.15
2	45	16	23	17	17	8	17	20.43	11.69	57.22
3	31	32	30	20	18	26	28	26.43	5.47	20.71
4	47	38	41	29	23	25	38	34.43	8.90	25.86
5	35	37	27	9	8	23	24	23.29	11.38	48.88
6	27	52	34	12	25	11	22	26.14	14.02	53.62
7	52	42	55	21	35	22	39	38.00	13.27	34.91
8	48	30	36	24	29	34	40	34.43	7.91	22.98
9	44	50	29	19	22	27	31	31.71	11.34	35.75
10	49	50	37	25	28	31	32	36.00	9.93	27.59
11	52	47	37	30	37	34	33	38.57	7.98	20.68
12	41	37	25	21	24	15	24	26.71	9.11	34.08
13	43	32	30	19	26	10	30	27.14	10.43	38.43
14	46	28	25	26	24	34	37	31.43	8.04	25.58

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-98. Species diversity (index H' of Shannon and Weaver 1963) data on benthic invertebrate collections made at stations near Big Bend from May to December 1979[a]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	1.42	1.93	1.90	1.00	1.77	1.50	2.10	1.66	0.38	22.74
2	2.51	0.86	1.92	2.15	1.03	0.59	2.04	1.59	0.74	46.89
3	2.04	2.71	2.24	2.11	1.82	2.18	1.65	2.11	0.34	16.00
4	1.74	2.87	3.22	2.83	2.19	2.49	1.22	2.37	0.70	29.64
5	2.14	2.58	2.41	1.76	1.46	1.90	1.43	1.95	0.45	22.82
6	2.37	2.71	2.63	1.76	2.72	1.50	1.31	2.14	0.61	28.24
7	2.44	3.00	2.45	1.97	2.49	2.23	2.41	2.43	0.31	12.82
8	2.31	1.25	3.06	2.43	2.44	2.55	1.87	2.27	0.57	25.14
9	1.91	2.69	2.74	1.95	2.22	2.19	1.57	2.18	0.42	19.39
10	2.14	3.24	3.08	2.41	2.40	2.45	1.73	2.49	0.52	20.89
11	2.20	2.94	2.97	2.70	2.21	2.31	2.26	2.51	0.32	12.77
12	2.84	2.09	2.35	2.29	1.68	1.92	1.72	2.13	0.41	19.14
13	2.45	1.34	2.44	2.30	1.88	1.16	2.41	2.00	0.55	27.50
14	1.53	2.16	2.66	2.45	2.07	2.45	2.34	2.24	0.37	16.47

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-99. Equitability (index J' of Pielou 1966) data on benthic invertebrate collections made at stations near Big Bend from May to December 1979[a]

Station	May 11	June 21, 22	August 2	August 24	September 19	November 1	December 13	Mean	Standard deviation	Coefficient of variation
1	0.34	0.60	0.65	0.52	0.54	0.48	0.60	0.53	0.10	19.22
2	0.66	0.31	0.61	0.76	0.36	0.29	0.72	0.53	0.20	38.30
3	0.59	0.78	0.66	0.71	0.63	0.67	0.49	0.65	0.09	14.18
4	0.45	0.79	0.87	0.84	0.70	0.77	0.34	0.68	0.20	30.07
5	0.60	0.71	0.73	0.80	0.70	0.61	0.45	0.66	0.11	17.43
6	0.72	0.68	0.75	0.71	0.84	0.63	0.43	0.68	0.13	18.79
7	0.62	0.80	0.61	0.65	0.70	0.72	0.66	0.68	0.07	9.72
8	0.60	0.37	0.85	0.76	0.72	0.72	0.51	0.65	0.16	25.42
9	0.50	0.69	0.82	0.66	0.72	0.67	0.46	0.65	0.13	19.42
10	0.55	0.83	0.85	0.75	0.72	0.71	0.50	0.70	0.13	18.85
11	0.56	0.76	0.82	0.79	0.61	0.66	0.65	0.69	0.98	14.13
12	0.76	0.58	0.73	0.75	0.53	0.71	0.54	0.66	0.10	15.61
13	0.65	0.39	0.72	0.78	0.58	0.50	0.71	0.62	0.14	22.23
14	0.40	0.65	0.83	0.75	0.65	0.70	0.65	0.66	0.13	20.14

[a] Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-100. Clusters of stations near Big Bend with high similarity (index $C\lambda$ of Morisita [1959] ≥ 0.07) of benthic invertebrate assemblages from May to December 1979[a]

Sampling date	Station													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
May 11	None	None	14	5,7,8, 9,10, 11	4,7,8, 9,10, 11	None	4,5,9, 10,11	4,5	4,5,7, 10,11	4,5,7, 9,11	4,5,7, 9,10	13	12	3
June 21,22	None	None	None	5	4,7, 12	9,11	5	None	6	None	6,10	5,13	12	None
August 2	2,3	1,3	1,2	10	6,12	5,9, 11,12, 13	None	10	6,10	4,8, 9,11	6,10	5,6, 13	6,12	None
August 24	None	None	None	None	8,10, 12	None	None	5,9, 10,11	8,10, 11	5,8, 9,11	8,9, 10	5,13	11,12	None
Sept. 19	None	5	14	7,8,9, 10	2	7	4,6,8, 9,10	4,7, 9,10	4,7, 8,10	4,7, 8,9	None	13	12	3
Nov. 1	None	None	None	8,9, 10,11	8,12	13	None	4,5,9, 10,11	4,8, 10,11	4,8, 9,11	4,8, 9,10	5,8	None	None
Dec. 13	All but 2,3,7, 14	None	14	All but 2,3,7, 14	All but 2,3,7, 14	All but 2,3,7, 13,14	13	All but 2,3,14	All but 2,3,14	All but 2,3,14	All but 2,3,14	All but 2,3,7, 14	All but 2,3,14	3

[a]Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-101. Clusters of stations near Big Bend with moderate to high similarity (index $C\lambda$ of Morisita [1959] ≥ 0.5) of benthic invertebrate assemblages from May to December 1979[a]

Sampling date	Station													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
May 11	2	1,6,8	14	5,7,8, 9,10,11	4,7,8, 9,10,11	2,8	4,5,8, 9,10,11	2,4,5, 6,7,9, 10,11	4,5,7, 8,10,11	4,5,7, 8,9,11	4,5,7, 8,9,10	13	12	3
June 21, 22	None	None	None	5,7,10, 12,13	4,7,10, 11,12,13	9,10,11	4,5,10, 11,12	None	6,10,11	4,5,6, 7,9,11	5,6,7, 9,10,	4,5,7, 13	4,5,12	None
August 2	2,3	1,3	1,2	5,6,8, 9,10,11	4,6,11, 12	4,5,8, 9,10,11, 12,13	None	4,6,9, 10,11	4,6,8, 10,11,12, 13	4,6,8, 9,11,12 13	4,5,6, 8,9,10 12,13	5,6,9, 10,11,13	6,9,10, 11,12	None
August 24	None	None	None	8,9,10, 11	6,8,9, 10,11,12, 13,14	5,8,11, 13,	12,13	4,5,6, 9,10,11, 12,13	4,5,8, 10,11,13	4,5,8, 9,11,12, 14	4,5,6, 8,9,10, 12,13	5,7,8, 10,11,13, 14	5,6,7, 8,9,11, 12	5,10,12
Sept. 19	2,3,5	1,5	1,14	7,8,9, 10	1,2	7,8,10	4,6,8, 9,10	4,6,7, 9,10,11	4,7,8, 10	4,6,7, 8,9	8	13	12	3
Nov. 1	3,6	None	1	7,8,9, 10,11,12	7,8,11, 12	1,7,8, 11,12	4,5,10, 12,13	4,5,7, 9,10,11, 12	4,8, 10,11,12	4,8,9, 11,12	4,5,8, 9,10,12	4,5,6, 7,8,9, 10,11,13	6,13	None
Dec. 13	All but 2,7,14	None	All but 2,7,11, 13	All but 2,7,14	All but 2,7,14	All but 2,7,14	8,9,10, 11,13	All but 2,14	All but 2,14	All but 2,14	All but 2,3,14	All but 2,7,14	All but 2,3,14	3

[a]Adapted from Mahadevan, Culter, and Yarbrough (1980).

Table 5-102. Mean abundance (number on 100 square centimeters of panel) and percent coverage of oyster spat on ten replicate spat panels set at five stations near Big Bend at approximately 2-week intervals from March 1979 to January 1980[a],[b]

Date	Station									
	A		B		C		D		E	
3/27/79	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
4/24[c]	--	--	--	--	--	--	--	--	5.5	(0.46)
4/26[c]	4.2	(0.44)	6.6	(0.92)	2.6	(0.45)	8.6	(0.40)	--	--
5/25	nd	nd	21.0	(0.90)	0.88	(0.22)	.5	(0.20)	11.3	(0.47)
6/19	60.1	(0.50)	182.1	(1.23)	10.6	(0.45)	2.9	(0.40)	8.5[d]	(1.50)
7/17	14.7	(0.50)	0.0	(0.00)	30.9	(2.75)	2.8	(0.45)	44.5	(1.75)
8/14	4.6	(0.50)	0.1	(.05)	2.0	(0.50)	18.5	(0.50)	6.4	(0.50)
9/14	10.3	(0.50)	2.5	(.04)	2.5	(0.40)	59.0	(0.50)	3.0	(0.50)
10/9	0.6	(0.30)	0.2	(0.10)	0.2	(0.10)	3.0	(0.45)	54.75	(0.50)
11/6	nd	nd	3.0	(0.45)	3.0	(0.45)	9.0	(0.50)	8.3	(0.50)
12/4	0.1	(0.05)	0.4	(0.15)	0.0	(0.00)	0.0	(0.00)	6.5	(0.50)
1/2/80	0.0	(0.00)	nd	nd	0.0	(0.00)	0.0	(0.00)	0.0	(0.00)
1/29	0.0	(0.00)	0.0	(0.00)	0.0	(0.00)	0.0	(0.00)	nd	nd
Average	9.46	(0.25)	13.6	(0.34)	4.39	(0.44)	8.69	(0.28)	13.5	(0.61)

Abbreviation: nd = no data; samples lost.

[a] Adapted from Blanchet (1980).

[b] Percent coverage indicated by number inside parentheses.

[c] Collections of 4/24 and 4/26 represent a single collection at all five stations. No collections were made at Stations A, B, C, and D on 4/24 or at Station E on 4/26.

[d] Data questionable; panels probably set for 8 weeks.

Table 5-103. Seasonal occurrence of fishes reported from collections made at Big Bend from 1972 to 1975[a] (Sheet 1 of 5)

Taxon	Spring	Summer	Fall	Winter
Dasyatis americana Southern stingray		X		
Dasyatis sabina Atlantic stingray		X	X	
Dasyatis sayi Bluntnose stingray	X	X		X
Gymnura micrura Smooth butterfly ray	X	X	X	X
Rhinoptera bonasus Cownose ray		X	X	X
Elops saurus Ladyfish		X	X	
Anguilla rostrata American eel			X	X
Ophichtus gomesi Shrimp eel	X	X		X
Brevoortia patronus Gulf menhaden	X		X	
Brevoortia tyrannus Atlantic menhaden			X	
Dorosoma cepedianum Gizzard shad	X			X
Dorosoma pretenense Threadfin shad	X		X	
Harengula jaguana Scaled sardine		X	X	X
Opisthonema oglinum Atlantic thread herring		X	X	
Sardinella anchovia Spanish sardine			X	
Anchoa hepsetus Striped anchovy	X	X	X	X
Anchoa mitchilli Bay anchovy	X	X	X	X
Synodus foetens Inshore lizardfish	X	X	X	X
Arius felis Sea catfish	X	X	X	X
Bagre marinus Gafftopsail catfish	X	X	X	X
Opsanus beta Gulf toadfish	X	X	X	X
Porichthys porosissimus Atlantic midshipman	X	X		X
Gobiesox strumosus Skilletfish	X	X	X	X

Note: See footnote at end of table.

Table 5-103. Seasonal occurrence of fishes reported from collections made at Big Bend from 1972 to 1975[a] (Sheet 2 of 5)

Taxon	Spring	Summer	Fall	Winter
Ogcocephalus nasutus Shortnose batfish	X	X		
Urophycis floridanus Southern hake	X			X
Hyporhamphus unifasciatus Halfbeak		X	X	X
Strongylura marina Atlantic needlefish		X	X	
Strongylura notata Redfin needlefish	X	X	X	
Strongylura timucu Timucu	X	X	X	X
Cyprinodon variegatus Sheepshead minnow	X	X	X	X
Floridicthys carpio Goldspotted killifish		X	X	
Fundulus grandis Gulf killifish	X	X	X	
Fundulus similis Longnose killifish	X	X	X	X
Lucania parva Rainwater killifish			X	X
Membras martinica Rough silverside	X	X	X	X
Menidia beryllina Tidewater silverside	X	X	X	X
Hippocampus erectus Lined seahorse	X	X	X	X
Syngnathus floridae Dusty pipefish		X	X	
Syngnathus louisianae Chain pipefish	X		X	X
Syngnathus scovelli Gulf pipefish	X	X	X	X
Centropomus undecimalis Snook		X	X	X
Diplectrum formosum Sand perch	X			X
Epinephelus itajara Jewfish	X	X	X	X
Caranx hippos Crevalle jack	X	X	X	X
Caranx latus Horse-eye jack		X		
Chloroscombrus chrysurus Atlantic bumper		X	X	X

Note: See footnote at end of table.

Table 5-103. Seasonal occurrence of fishes reported from collections made at Big Bend from 1972 to 1975[a] (Sheet 3 of 5)

Taxon	Spring	Summer	Fall	Winter
Hemicaranx amblyrhynchus Bluntnose jack		X	X	X
Oligoplites saurus Leatherjacket	X	X	X	X
Selene vomer Lookdown		X	X	X
Trachinotus falcatus Permit		X	X	X
Trachinotus goodei Palometa		X	X	
Lutjanus griseus Gray snapper	X	X	X	X
Diapterus plumieri Striped mojarra	X	X	X	X
Eucinostomus argenteus Spotfin mojarra	X	X	X	X
Eucinostomus gula Silver jenny	X	X	X	X
Gerres cinereus Yellowfin mojarra		X	X	
Orthopristis chrysoptera Pigfish	X	X	X	X
Archosargus probatocephalus Sheepshead	X	X	X	X
Lagodon rhomboides Pinfish	X	X	X	X
Bairdiella chrysoura Silver perch	X	X	X	X
Cynoscion arenarius Sand seatrout	X	X	X	X
Cynoscion nebulosus Spotted seatrout	X	X	X	X
Cynoscion nothus Silver seatrout	X	X	X	
Cynoscion regalis Weakfish	X	X		
Leiostomus xanthurus Spot	X	X	X	X
Menticirrhus americanus Southern kingfish	X	X	X	X
Menticirrhus saxatilis Minkfish	X	X	X	X
Menticirrhus littoralis Gulf kingfish		X	X	X
Micropogon undulatus Atlantic croaker	X	X		X

Note: See footnote at end of table.

Table 5-103. Seasonal occurrence of fishes reported from collections made at Big Bend from 1972 to 1975[a] (Sheet 4 of 5)

Taxon	Spring	Summer	Fall	Winter
Pogonias cromis Black drum	X	X	X	X
Sciaenops ocellata Red drum	X	X	X	X
Chaetodipterus faber Atlantic spadefish	X	X	X	X
Tilapia melanotheron Blackchin mouthbrooder		X		X
Mugil cephalus Striped mullet	X	X	X	X
Mugil trichodon Fantail mullet	X	X	X	X
Labrisomus nuchipinnis Hairy blenny		X	X	X
Chasmodes saburrae Florida blenny		X	X	X
Hypsoblennius hentzi Feather blenny	X	X		X
Bathygobius soporator Frillfin goby	X	X	X	X
Gobiosoma robustum Code goby		X	X	X
Microgobius gulosus Clown goby	X	X		X
Peprilus alepidotus Harvestfish		X	X	X
Prionotus scitulus Leopard searobin	X	X	X	X
Prionotus tribulus Bighead searobin	X	X	X	X
Paralichthys albigutta Gulf flounder	X	X	X	X
Paralichthys dentatus Summer flounder		X	X	
Achirus lineatus Lined sole	X	X	X	X
Trinectes inscriptus Scrawled sole			X	
Trinectes maculatus Hogchoker	X	X	X	X
Symphurus plagiusa Blackcheek tonguefish	X	X	X	X
Aluterus schoepfi Orange filefish		X	X	X
Monacanthus hispidus Planehead filefish	X	X	X	X

Note: See footnote at end of table.

Table 5-103. Seasonal occurrence of fishes reported from collections made at Big Bend from 1972 to 1975[a] (Sheet 5 of 5)

Taxon	Spring	Summer	Fall	Winter
Lactophrys quadricornis Scrawled cowfish	X	X		X
Sphoeroides nephelus Southern puffer	X	X	X	X
Sphoeroides spengleri Bandtail puffer			X	
Chilomycterus schoepfi Striped burrfish	X	X	X	X

[a] Adapted from Tampa Electric Company (1976b).

Table 5-104. Fish taxa reported from impingement studies conducted at the Big Bend Powerplant during 1972-1975[a]

Dasyatis sayi
Gymnura micrura
Unidentified rajid
Elops saurus
Callechelys sp.
Ophichthus gomesi
Brevoortia patronus
Brevoortia sp.
Dorosoma cepedianum
Harengula jaguana
Opisthonema oglinum
Anchoa hepsetus
Anchoa mitchilli
Synodus foetens
Arius felis
Bagre marinus
Opsanus beta
Porichthys porosissimus
Gobiesox strumosus
Ogcocephalus nasutus
Urophycis floridanus
Ophidion holbrooki
Hyporhamphis unifasciatus
Strongylura timucu
Fundulus similis
Membras martinica
Menidia beryllina
Hippocampus erectus
Syngnathus louisianae
Syngnathus spp.
Caranx bartholomaei
Caranx hippos
Caranx latus
Chloroscombrus chrysurus
Hemicaranx amblyrhynchus
Oligoplites saurus
Selene vomer
Lutjanus griseus
Diapterus plumieri
Eucinostomus argenteus
Eucinostomus gula
Orthopristis chrysoptera
Lagodon rhomboides
Bairdiella chrysoura
Cynoscion arenarius
Cynoscion nebulosus
Leiostomus xanthurus
Menticirrhus americanus
Menticirrhus saxatilis
Menticirrhus sp.
Micropogon undulatus
Pogonias chromis
Sciaenops ocellata
Chaetodipterus faber
Mugil cephalus
Hypsoblennius hentzi
Peprilus alepidotus
Prionotus scitulus
Prionotus tribulus
Paralichthys albigutta
Achirus lineatus
Trinectes maculatus
Unidentified soleid
Symphurus plaguisa
Alutera scripta
Monacanthus hispidus
Lactophrys quadricornis
Sphoeriodes nephelus
Chilomycterus schoepfi
Diodon holacanthus

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[a] Adapted from Tampa Electric Company (1975a).

Table 5-105. Summary data on the distribution of the fish taxa most commonly collected by seine at Big Bend from January 1976 to March 1977[a]

Taxon	Number collected	Size range (mm)	Temperature range (^oC)	Approximate period of occurrence	Location of greatest abundance
Tidewater silverside *Menidia beryllina*	20,256	14-96	12-34.5	Year-round	Ubiquitous
Bay anchovy *Anchoa mitchilli*	9,171	18-65	16-32	Fall	Inshore shallows
Longnose killifish *Fundulus similis*	7,704	9-117	12-34.5	Year-round	Inshore shallows
Spotfin mojarra *Eucinostomus argenteus*	5,541	11-105	14-34.5	Late summer, early winter	Inshore shallows
Striped mullet *Mugil cephalus*	3,005	15-360	12-34	Year-round	Inshore shallows
Sheepshead minnow *Cyprinodon variegatus*	2,961	14-58	14-34.5	Late spring, summer	North Apollo embayment
Silver jenny *Eucinostomus gula*	2,451	31-100	15-34.5	Fall	Inshore shallows
Scaled sardine *Harengula jaguana*	1,721	62-138	12-34	Summer, fall	Open bay
Pinfish *Lagodon rhomboides*	1,465	16-136	18-34.5	Spring, summer	Shallow, sandy areas
Spot *Leiostomus xanthurus*	1,035	16-104	14-27.5	Late winter, spring	Inshore shallows
Northern kingfish *Menticirrhus saxatilis*	243	15-137	16-31.5	Summer	Open bay
Permit *Trachinotus falcatus*	114	15-410	18-33	Summer, fall	Open bay

[a] Adapted from Tampa Electric Company (1980a).

Table 5-106. Seasonal occurrence of fish taxa reported from impingement collections made at the Big Bend Powerplant from January 1976 to March 1977[a] (Sheet 1 of 2)

Taxon	Jan.-March	April-June	July-Sept.	Oct.-Dec.	Jan.-March
Sphyrna tiburo				X	
Dasyatis americana			X		
Dasyatis sayi		X			
Gymnura micrura	X				X
Rhinoptera bonasus					X
Elops saurus					X
Ophichthus gomesi					X
Harengula jaguana		X		X	X
Opisthonema oglinum	X		X	X	X
Anchoa hepsetus				X	X
Anchoa mitchilli	X	X	X	X	X
Synodus foetens	X				
Arius felis	X		X	X	X
Bagre marinus				X	
Opsanus beta	X	X	X	X	X
Porichthys porosissmus	X				
Gobiesox strumosus	X	X	X		
Urophycis floridanus					X
Hyporhamphus unifasciatus	X	X			
Strongylura timucu					X
Cyprinodon variegatus					X
Lucania parva		X			
Membras martinica	X			X	X
Menidia beryllina	X	X			X
Hippocampus erectus	X	X		X	X
Syngnathus louisianae					X
Syngnathus scovelli				X	
Caranx hippos					X
Chloroscombrus chrysurus	X	X	X	X	X
Hemicaranx amblyrhynchus			X	X	
Oligoplites saurus			X	X	
Selene vomer			X	X	
Diapterus plumieri	X			X	
Eucinostomus argenteus	X	X	X	X	X
Eucinostomus gula	X	X	X	X	X
Orthopristis chrysoptera		X	X	X	X
Archosargus probatocephalus			X		
Lagodon rhomboides	X	X	X	X	X
Bairdiella chrysoura	X	X	X	X	X
Cynoscion arenarius	X	X	X	X	X

Note: See footnote at end of table.

Table 5-106. Seasonal occurrence of fish taxa reported from impingement collections made at the Big Bend Powerplant from January 1976 to March 1977[a] (Sheet 2 of 2)

Taxon	Jan.-March	April-June	July-Sept.	Oct.-Dec.	Jan.-March
Cynoscion nebulosus		X	X	X	X
Leiostomus xanthurus		X			
Menticirrhus americanus		X			
Menticirrhus saxatilis		X		X	X
Micropogon undulatus		X			
Sciaenops ocellata	X	X		X	X
Chaetodipterus faber	X	X	X	X	X
Mugil cephalus		X			
Astroscopus y-graecum		X		X	
Hypsoblennius hentzi	X			X	X
Bathygobius soporator			X		
Prionotus scitulus	X	X	X	X	X
Prionotus tribulus	X	X		X	X
Achirus lineatus	X	X	X	X	X
Trinectes maculatus			X	X	X
Symphurus plagiusa	X	X	X	X	X
Monocanthus hispidus	X	X		X	X
Acanthostracion quadricornis					X
Sphoeroides nephalus	X	X		X	X
Chilomycterus schoepfi	X	X	X	X	X

[a] Adapted from Peekstok, Page, and Haynes (1977).

Table 5-107. Non-RIS fish taxa reported from Big Bend seine, trawl, and impingement collections made from March 1979 to February 1980[a] (Sheet 1 of 4)

Taxon	Collections		
	Seine	Trawl	Impingement
Carcharhinus limbatus Blacktip shark			X
Dasyatis americana Southern stingray	X	X	
Dasyatis sayi Bluntnose stingray			X
Gymnura micrura Smooth butterfly ray		X	X
Rhinoptera bonasus Cownose ray		X	X
Myrophis punctatus Speckled worm eel			X
Ophichthus gomesi Shrimp eel			X
Brevoortia smithi Yellowfin menhaden	X	X	X
Dorosoma petenense Threadfin shad	X		X
Opisthonema oglinum Atlantic thread herring	X	X	X
Anchoa hepsetus Striped anchovy	X	X	X
Synodus foetens Inshore lizardfish	X		
Arius felis Sea catfish	X	X	X
Bagre marinus Gafftopsail catfish		X	X
Opsanus beta Gulf toadfish		X	X
Porichthys porosissimus Atlantic midshipman		X	
Gobiesox strumosus Skilletfish			X
Urophycis floridanus Southern hake		X	
Hyporhamphus unifasciatus Halfbeak	X		
Strongylura notata Redfin needlefish	X		
Strongylura timucu Timucu	X		
Cyprinodon variegatus Sheepshead minnow	X		

Note: See abbreviation and footnote at end of table.

Table 5-107. Non-RIS fish taxa reported from Big Bend seine, trawl, and impingement collections made from March 1979 to February 1980[a] (Sheet 2 of 4)

Taxon	Collections		
	Seine	Trawl	Impingement
Floridichthys carpio Goldspotted killifish	X		
Fundulus grandis Gulf killifish	X		
Fundulus similis Longnose killifish	X		
Membras martinica Rough silverside	X		
Hippocampus erectus Lined seahorse		X	X
Hippocampus zosterae Dwarf seahorse	X		
Syngnathus louisianae Chain pipefish	X		X
Syngnathus scovelli Gulf pipefish		X	
Centropomus undecimalis Snook	X	X	X
Diplectrum formosum Sand perch		X	
Caranx hippos Crevalle jack			X
Chloroscombrus chrysurus Atlantic bumper	X	X	X
Hemicaranx amblyrhynchus Bluntnose jack			X
Oligoplites saurus Leatherjacket	X		
Selene vomer Lookdown			X
Trachinotus falcatus Permit	X		
Diapterus plumieri Striped mojarra	X	X	X
Eucinostomus argenteus Spotfin mojarra	X	X	X
Eucinostomus gula Silver jenny	X	X	X
Eucinostomus lefroyi Mottled mojarra	X	X	
Gerres cinereus Yellowfin mojarra	X		
Orthopristis chrysoptera Pigfish	X	X	X

Note: See abbreviation and footnote at end of table.

Table 5-107. Non-RIS fish taxa reported from Big Bend seine, trawl, and impingement collections made from March 1979 to February 1980[a] (Sheet 3 of 4)

Taxon	Collections		
	Seine	Trawl	Impingement
Archosargus probatocephalus Sheepshead	X	X	
Lagodon rhomboides Pinfish	X	X	X
Cynoscion arenarius Sand seatrout		X	X
Leiostomus xanthurus Spot	X	X	X
Menticirrhus americanus Southern kingfish	X	X	X
Menticirrhus saxatilis Northern kingfish	X		X
Micropogon undulatus Atlantic croaker	X	X	
Sciaenops ocellata Red drum	X	X	X
Chaetodipterus faber Atlantic spadefish	X	X	X
Tilapia sp. Tilapia	X		
Mugil cephalus Striped mullet	X	X	X
Mugil trichodon Fantail mullet	X		
Astroscopus y-graecum Southern stargazer	X		X
Hypsoblennius hentzi Feather blenny		X	X
Microgobius gulosus Clown goby		X	
Prionotus scitulus Leopard searobin	X	X	X
Prionotus tribulus Bighead searobin	X	X	X
Ancylopsetta quadrocellata Ocellated flounder		X	
Etropus crossotus Fringed flounder		X	
Paralichthys albigutta Gulf flounder	X	X	X
Achirus lineatus Lined sole	X	X	X
Trinectes maculatus Hogchoker	X	X	X

Note: See abbreviation and footnote at end of table.

Table 5-107. Non-RIS fish taxa reported from Big Bend seine, trawl, and impingement collections made from March 1979 to February 1980[a] (Sheet 4 of 4)

Taxon	Collections		
	Seine	Trawl	Impingement
Symphurus plagiusa Blackcheek tonguefish	X	X	X
Aluterus schoepfi Orange filefish			X
Monacanthus hispidus Planehead filefish	X		X
Lactophrys quadricornis Scrawled cowfish	X	X	X
Sphoeroides nephelus Southern puffer		X	X
Chilomycterus schoepfi Striped burrfish		X	X

Abbreviation: RIS = representative important species.

[a] Adapted from Comp (1980).

Table 5-108. Whales and dolphins whose geographic ranges include coastal waters adjacent to or near the Big Bend site[a]

Common name	Scientific name	Status	
		State	Federal
Tropical beaked whale	*Mesoplodon densirostris*		
Gervais' beaked whale	*Mesoplodon europaeus*		
True's beaked whale	*Mesoplodon mirus*		
Goose-beaked whale	*Ziphius cavirostris*		
Sperm whale	*Physeter catodon*	E	E
Pygmy sperm whale	*Kogia breviceps*		
Spotted porpoise	*Stenella dubia*		
Long-beaked porpoise	*Stenella longirostris*		
Striped porpoise	*Stenella caeruleoalba*		
Rough-toothed porpoise	*Steno bredanensis*		
Common or saddle-backed porpoise	*Delphinus delphis*		
Bottle-nosed dolphin	*Tursiops truncatus*		
Grampus or Risso's dolphin	*Grampus griseus*		
False killer whale	*Pseudorca crassidens*		
Short-finned pilot whale	*Globicephala macrorhyncha*		
Fin whale	*Balaenoptera physalus*	E	E
Sei whale or rorqual	*Balaenoptera borealis*	E	E
Little piked whale	*Balaenoptera acutorostrata*		
Blue or sulphur-bottomed whale	*Balaenoptera musculus*		
Hump-backed whale	*Megaptera novaeangliae*	E	E
Right whale	*Balaena glacialis*		

Abbreviation: E = Endangered.

[a] List compiled from Hall and Kelson (1959), Burt and Grossenheider (1976), Layne et al. (1977), and Layne (1978). Only the bottle-nosed dolphin could occur in Tampa Bay with any regularity; other species could occur offshore in the Gulf of Mexico.

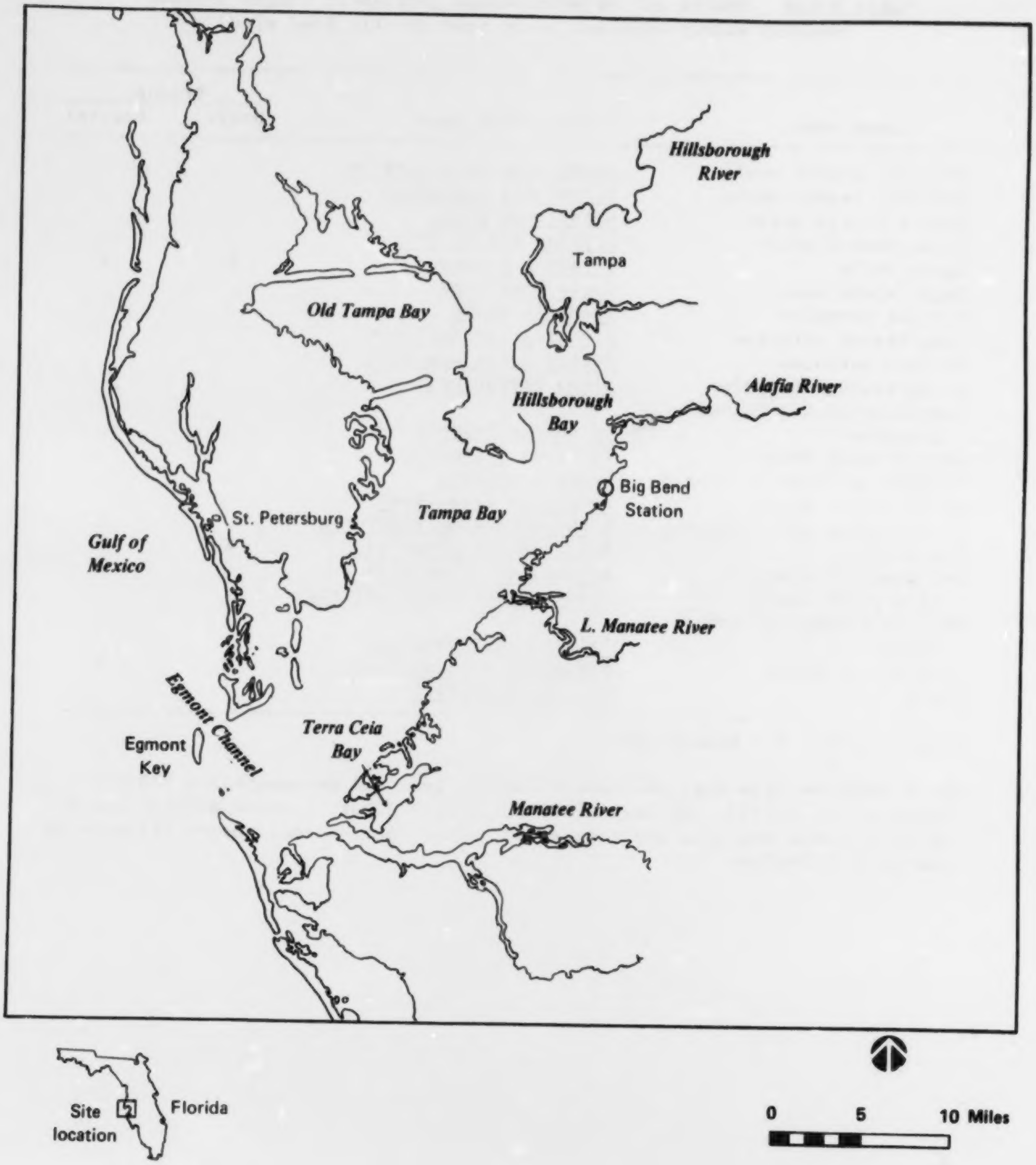
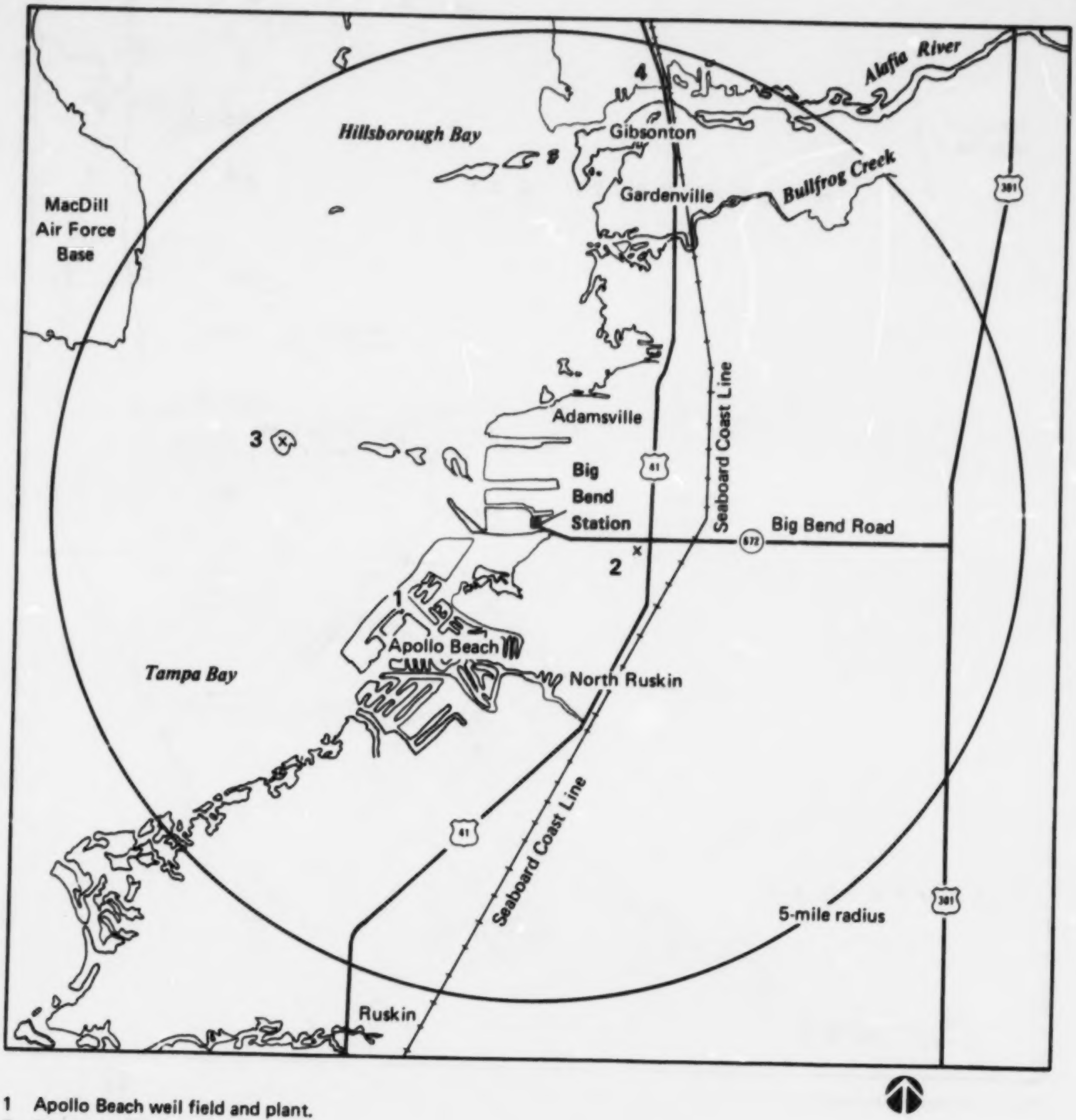

Hillsborough River
Tampa
Old Tampa Bay
Hillsborough Bay
Alafia River
Big Bend Station
Tampa Bay
St. Petersburg
Gulf of Mexico
L. Manatee River
Egmont Channel
Egmont Key
Terra Ceia Bay
Manatee River
Site location
Florida
0
5
10 Miles

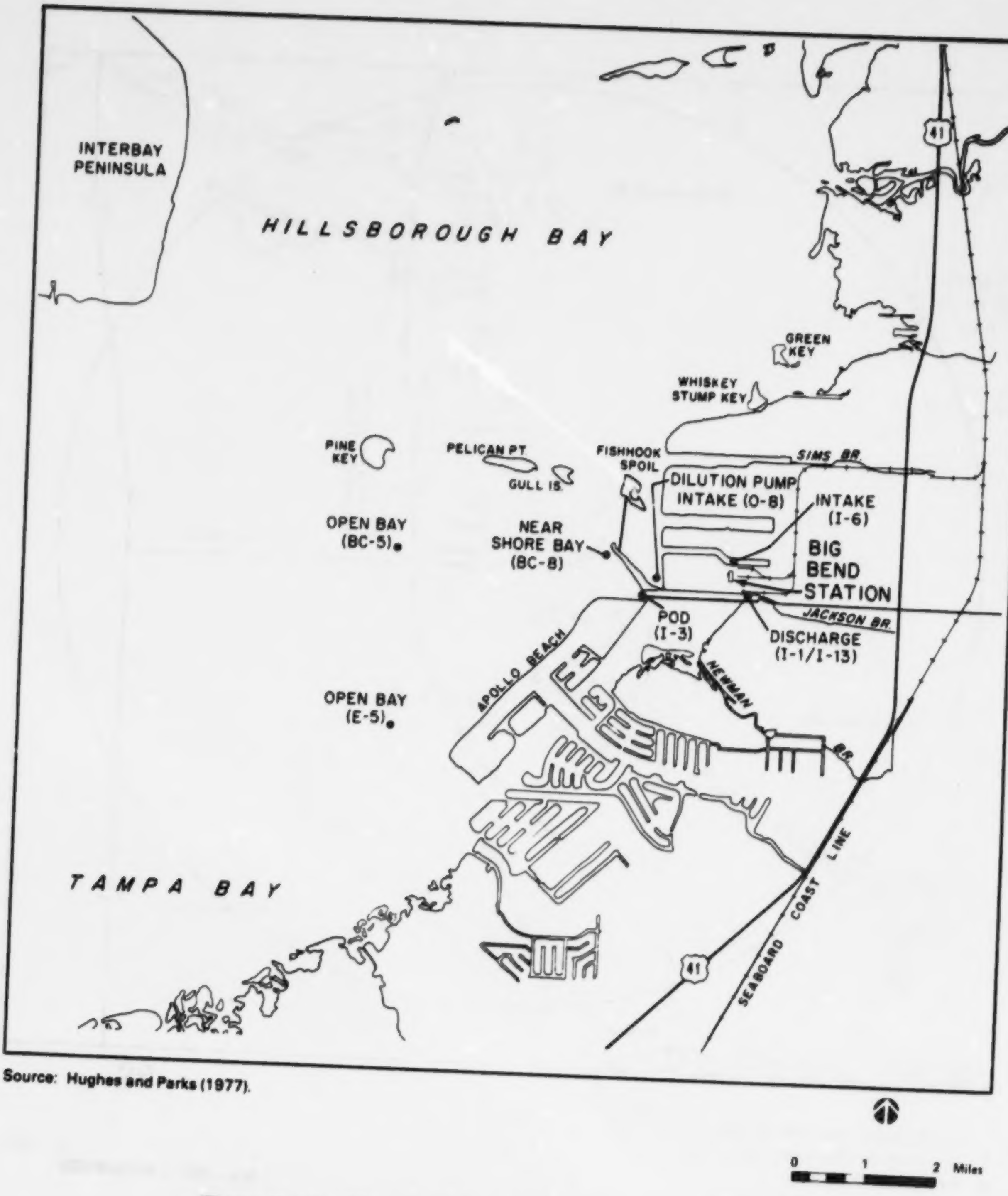
Figure 5-16. The Tampa Bay system.


Hillsborough Bay
MacDill Air Force Base
Gibsonton
Gardenville
Alafia River
Bullfrog Creek
301
Adamsville
3
Big Bend Station
41
Seaboard Coast Line
Big Bend Road
672
2
1
Apollo Beach
North Ruskin
Tampa Bay
41
Seaboard Coast Line
301
5-mile radius
Ruskin
4
8

1 Apollo Beach weil field and plant.
2 Riverview weil field and water plant.
3 Pine Key, Tampa Bay.
4 Alafia River and U.S. 41.

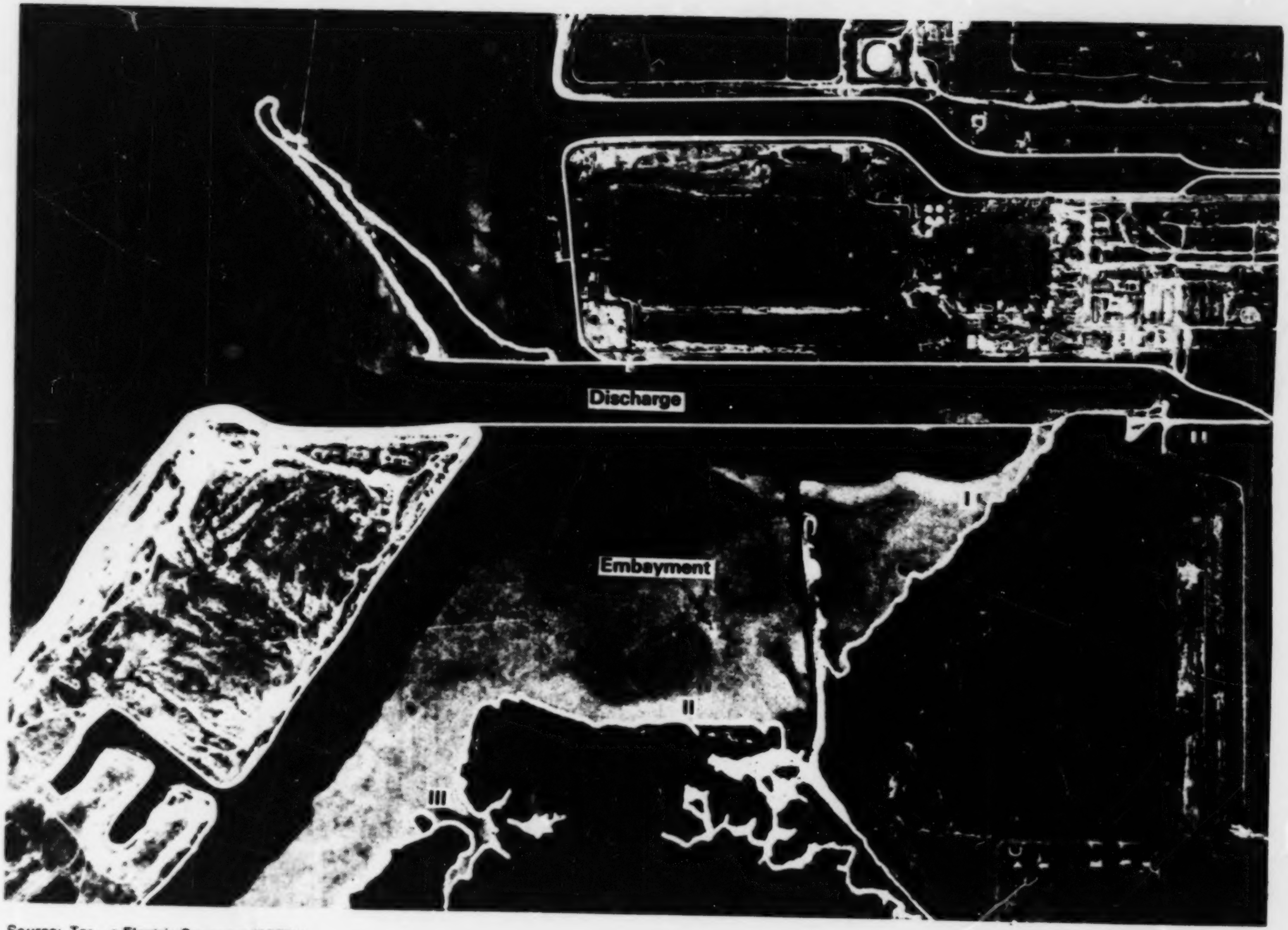
0 1 2 Miles

Figure 5-17. Site and contiguous area.


INTERBAY PENINSULA
HILLSBOROUGH BAY
41
GREEN KEY
WHISKEY STUMP KEY
PINE KEY
PELICAN PT
GULL IS.
FISHHOOK SPOIL
SIMS BR.
DILUTION PUMP INTAKE (O-8)
INTAKE (I-6)
OPEN BAY (BC-5)
NEAR SHORE BAY (BC-8)
BIG BEND STATION
POD (I-3)
JACKSON BR.
DISCHARGE (I-1/I-13)
APOLLO BEACH
NEWMAN BR.
OPEN BAY (E-5)
TAMPA BAY
SEABOARD COAST LINE
41
0
1
2 Miles

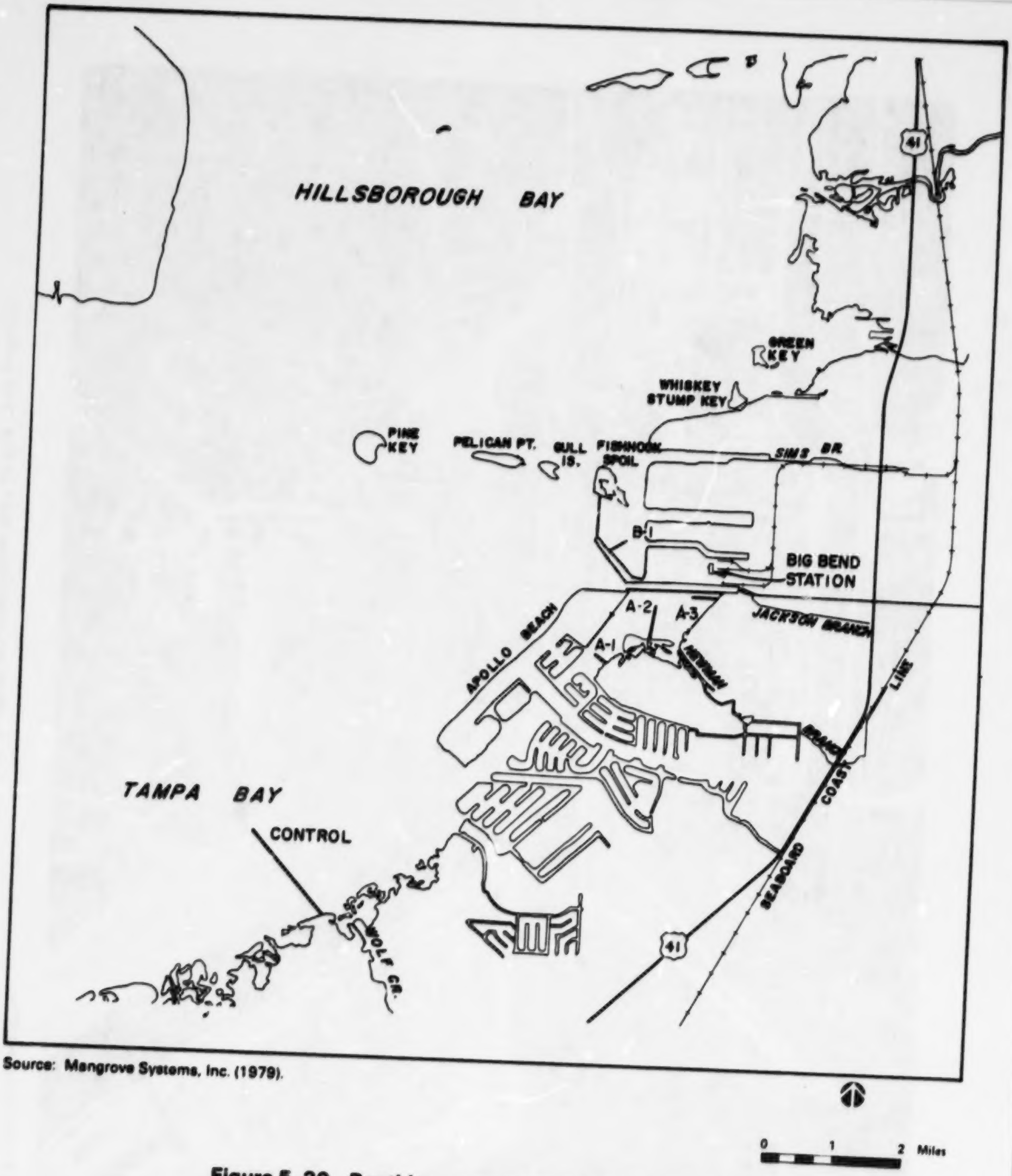
Source: Hughes and Parks (1977).

Figure 5-18. Phytoplankton sampling stations at Big Bend, January 1976-March 1977.


Discharge
Embayment
I
II
III

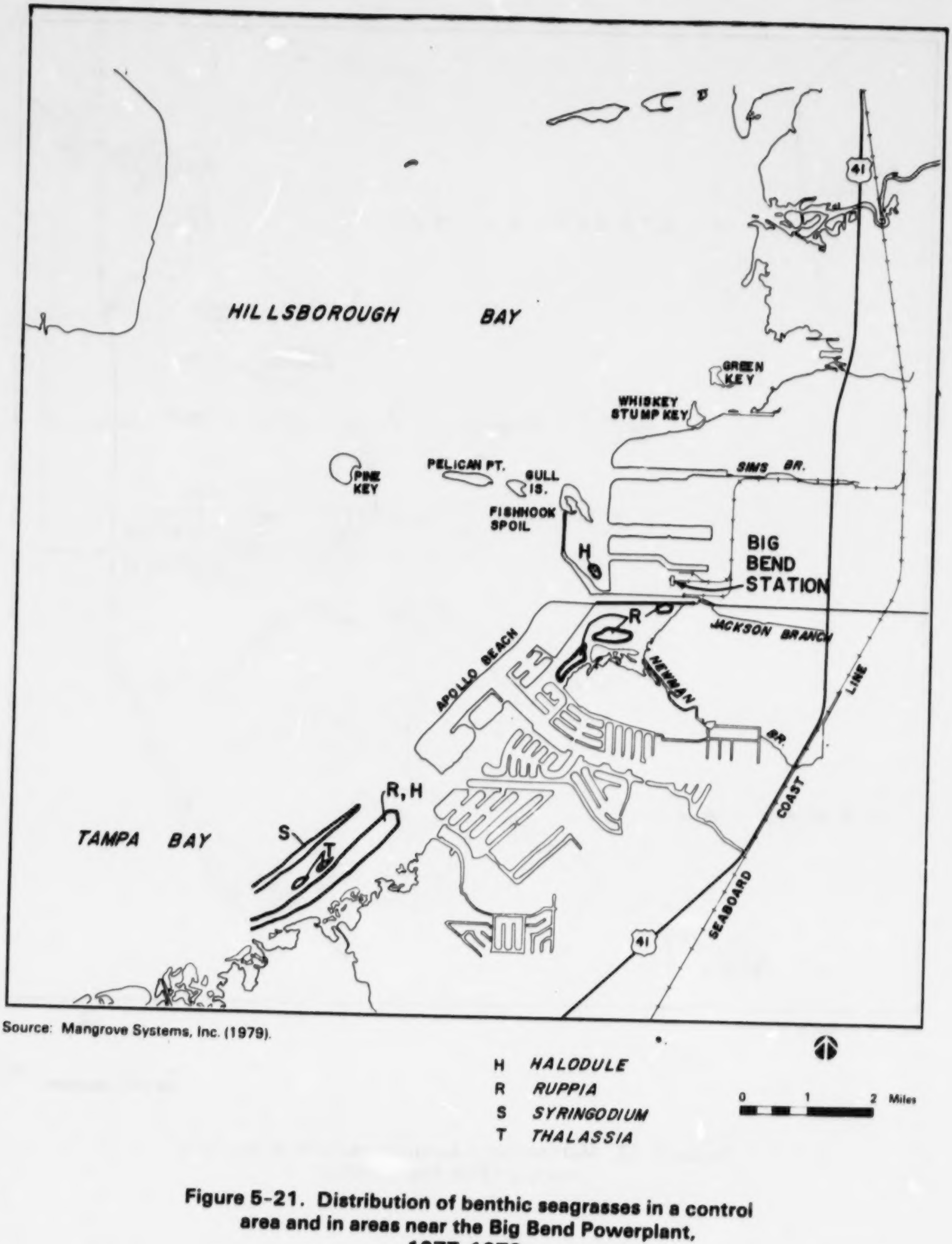
Source: Tampa Electric Company (1975b).

Figure 5-19. Sites of collection of benthic macrophytes within the embayment near the Big Bend Powerplant during 1975.


HILLSBOROUGH BAY
41
GREEN KEY
WHISKEY STUMP KEY
PINE KEY
PELICAN PT.
GULL IS.
FISHHOOK SPOIL
SIMS BR.
B-1
BIG BEND STATION
A-2
A-3
A-1
JACKSON BRANCH
APOLLO BEACH
BRANCH
LINE
COAST
SEABOARD
TAMPA BAY
CONTROL
WOLF CR.
41
0
1
2 Miles

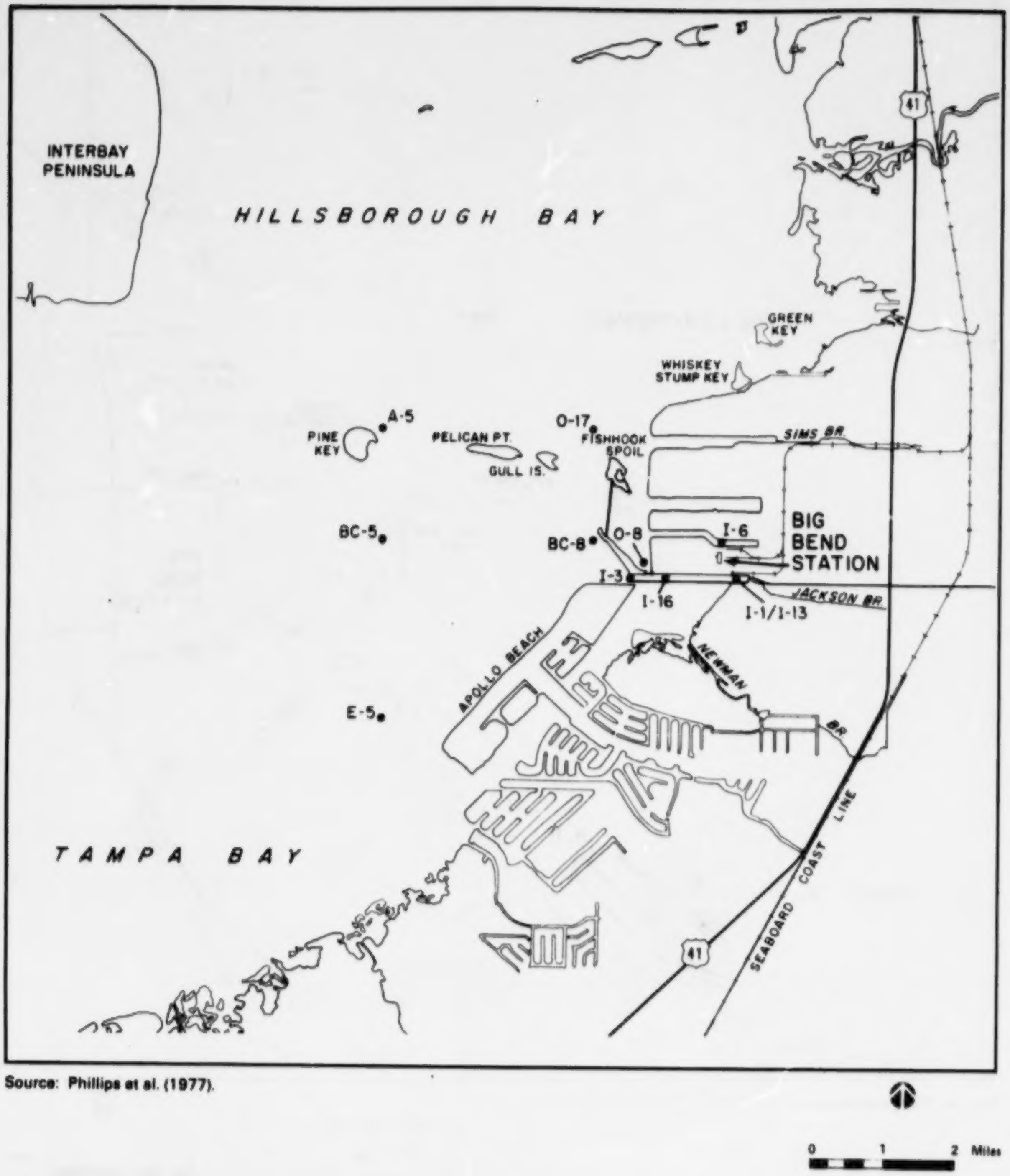
Source: Mangrove Systems, Inc. (1979).

Figure 5-20. Benthic seagrass sampling transects near Big Bend, 1977-1978.


HILLSBOROUGH BAY
TAMPA BAY
41
GREEN KEY
WHISKEY STUMP KEY
PELICAN PT.
GULL IS.
PINE KEY
FISHHOOK SPOIL
SIMS BR.
BIG BEND STATION
H
R
JACKSON BRANCH
APOLLO BEACH
NEWMAN BR.
SEABOARD COAST LINE
R, H
S
T
41
H HALODULE
R RUPPIA
S SYRINGODIUM
T THALASSIA
0 1 2 Miles

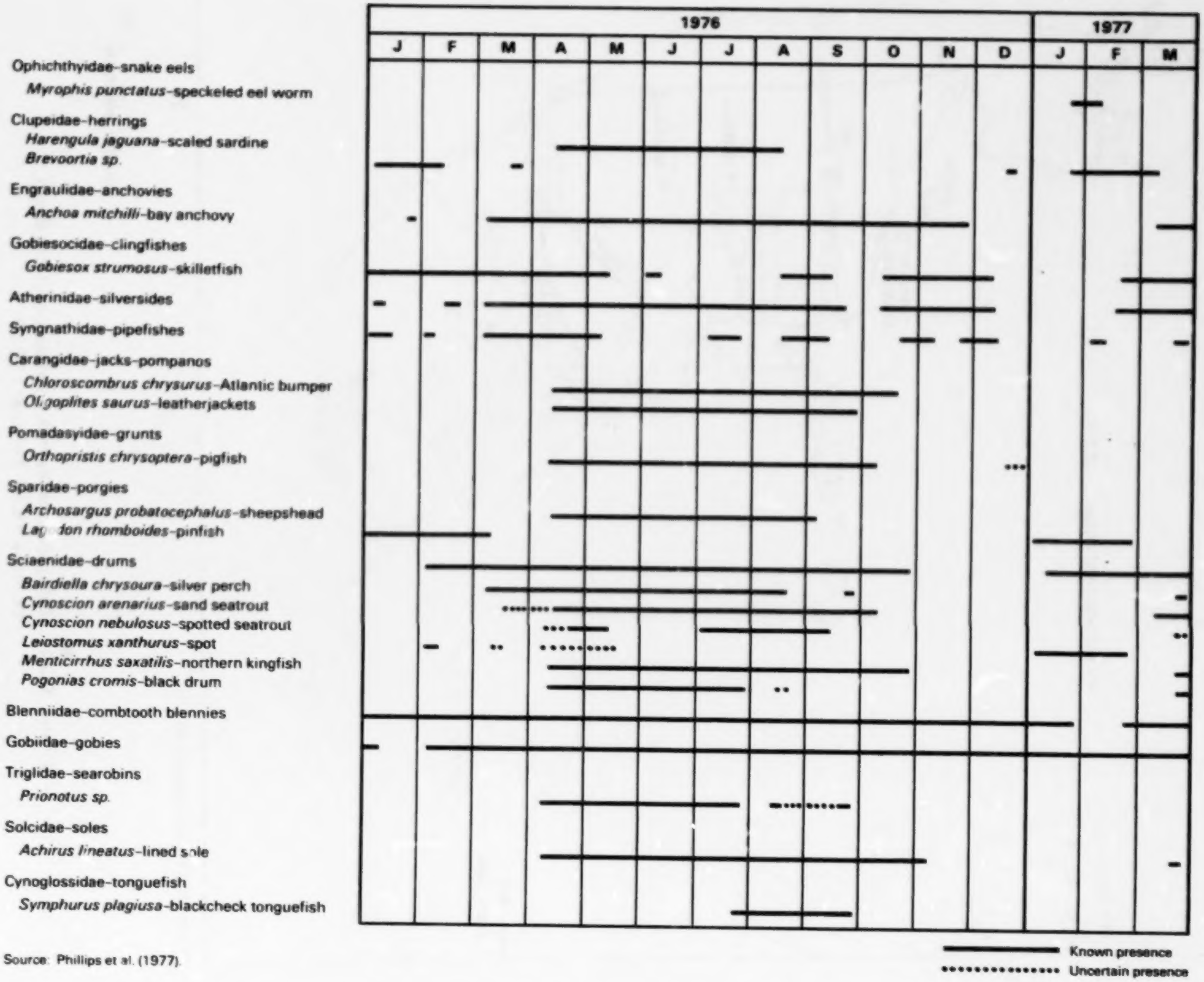
Source: Mangrove Systems, Inc. (1979).

Figure 5-21. Distribution of benthic seagrasses in a control area and in areas near the Big Bend Powerplant, 1977-1978.


INTERBAY PENINSULA
HILLSBOROUGH BAY
41
GREEN KEY
WHISKEY STUMP KEY
A-5
PINE KEY
PELICAN PT.
GULL IS.
O-17
FISHHOOK SPOIL
SIMS BR.
BC-5
BC-8
O-8
I-6
BIG BEND STATION
I-3
I-16
I-1/I-13
JACKSON BR.
APOLLO BEACH
NEWMAN BR.
E-5
TAMPA BAY
SEABOARD COAST LINE
41
0
1
2 Miles

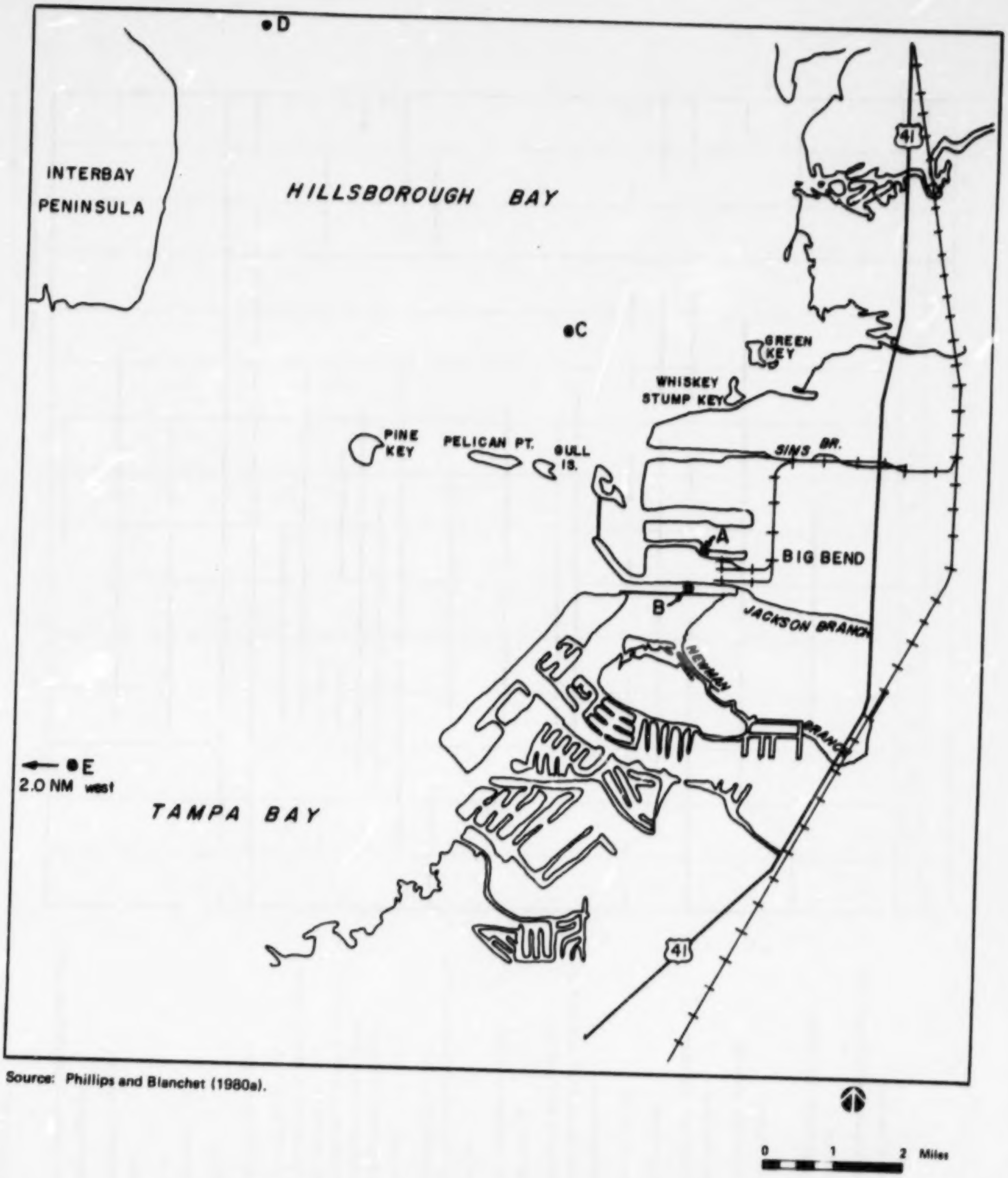
Source: Phillips et al. (1977).

Figure 5-22. Meroplankton sampling stations at Big Bend, January 1976-March 1977.



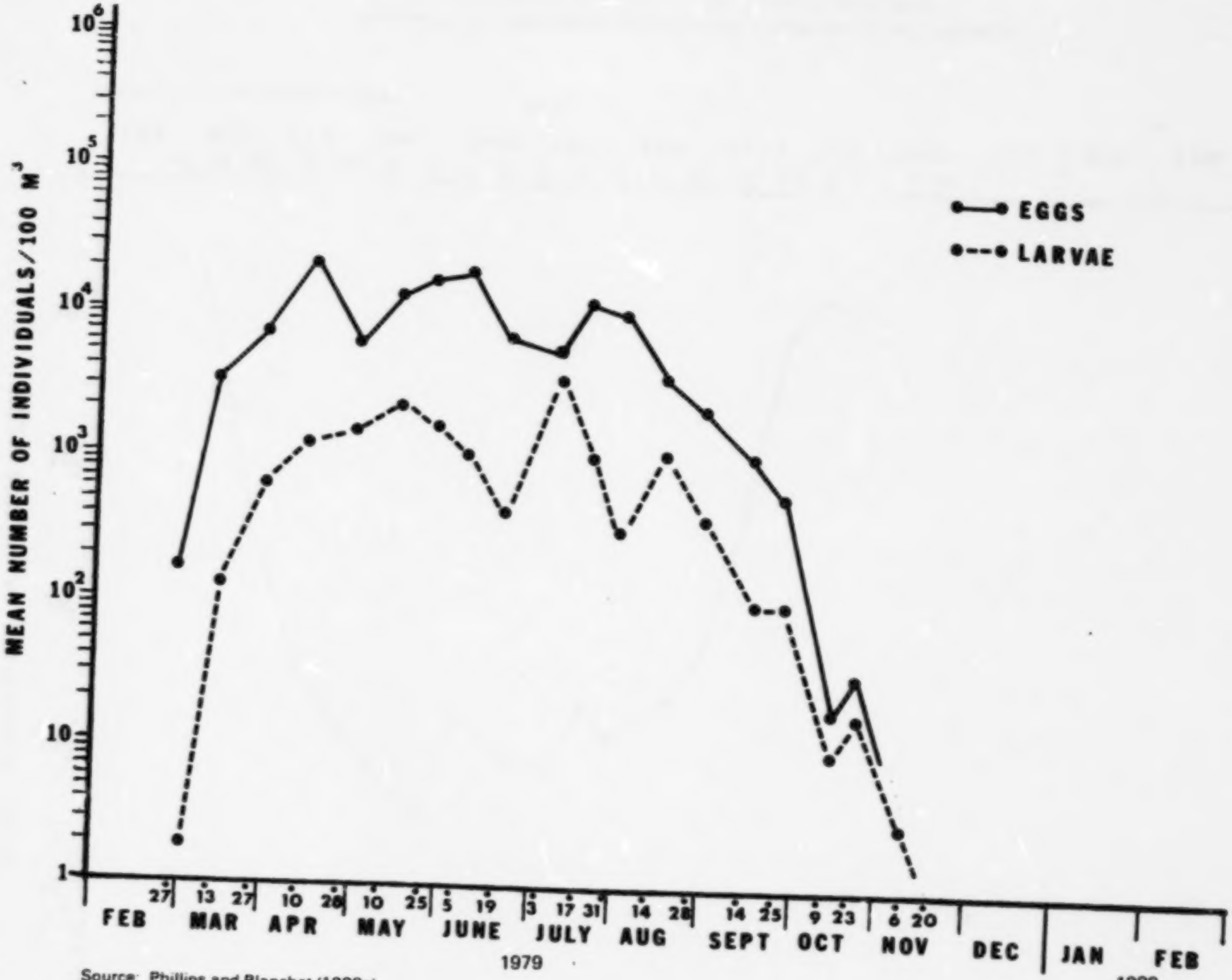
Source: Phillips et al. (1977).

Figure 5-23. Seasonal occurrence of fish larvae in the Big Bend area during 1976-1977.


D
INTERBAY
PENINSULA
HILLSBOROUGH BAY
41
C
GREEN
KEY
WHISKEY
STUMP KEY
PINE
KEY
PELICAN PT.
GULL
IS.
SINS BR.
A
BIG BEND
B
JACKSON BRANCH
NEWMAN
BRANCH
E
2.0 NM west
TAMPA BAY
41
0
1
2 Miles

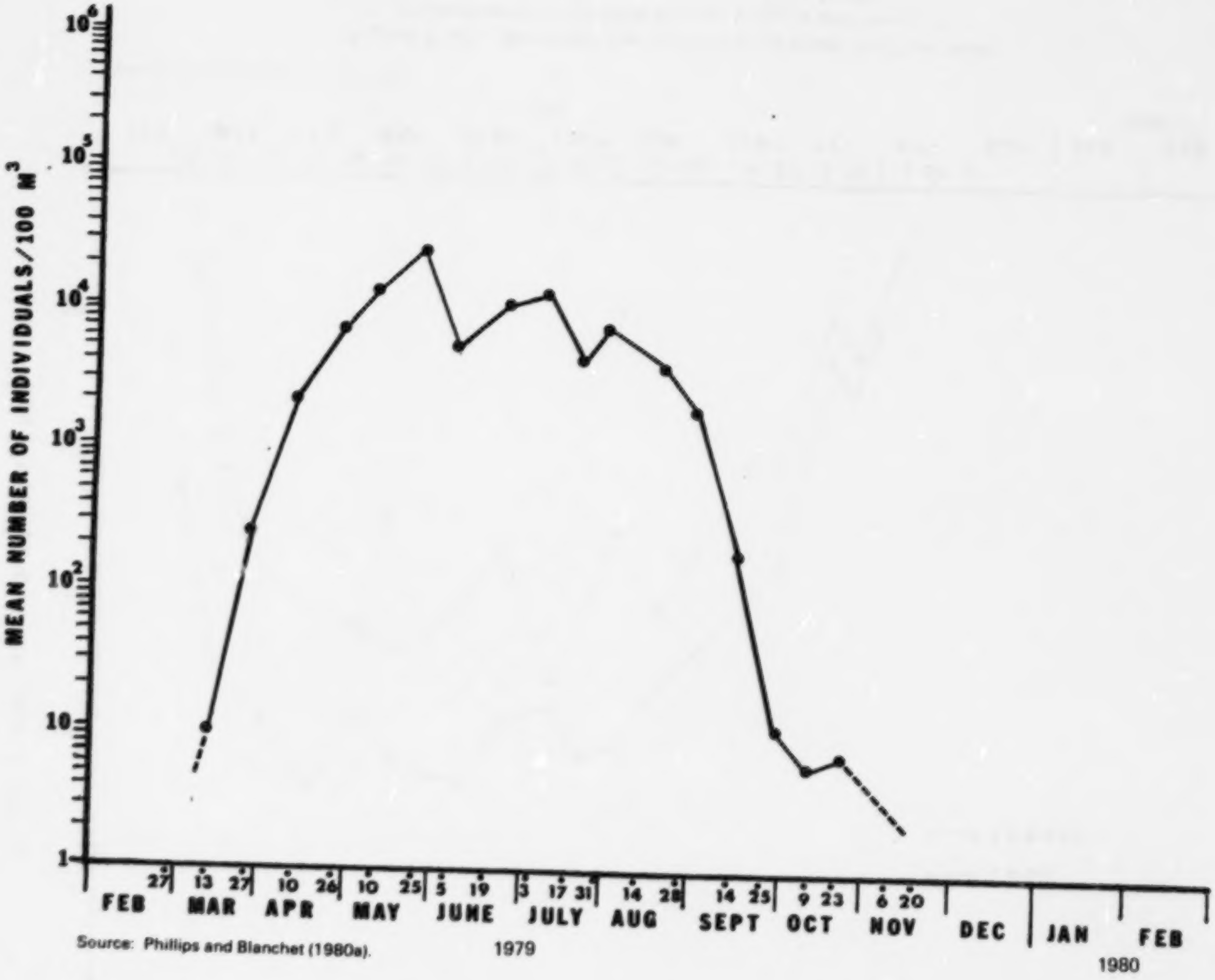
Source: Phillips and Blanchet (1980a).

Figure 5-24. Meroplankton sampling stations at Big Bend, February 1979-February 1980.



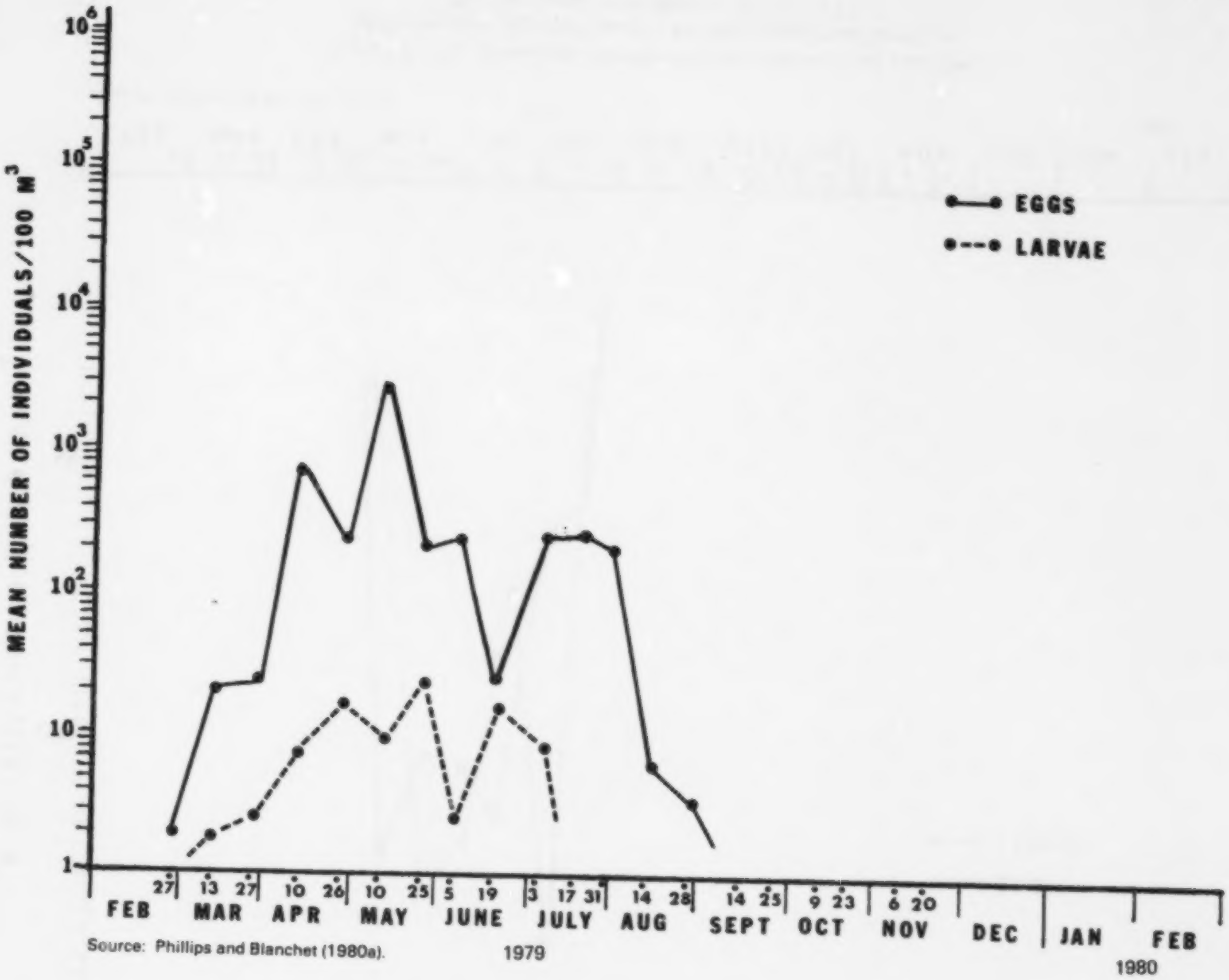
Source: Phillips and Blanchet (1980a).

Figure 5-25. Seasonal distribution (averages of all stations) of *Anchoa mitchilli* (bay anchovy) eggs and larvae in the Big Bend area during 1979-1980.



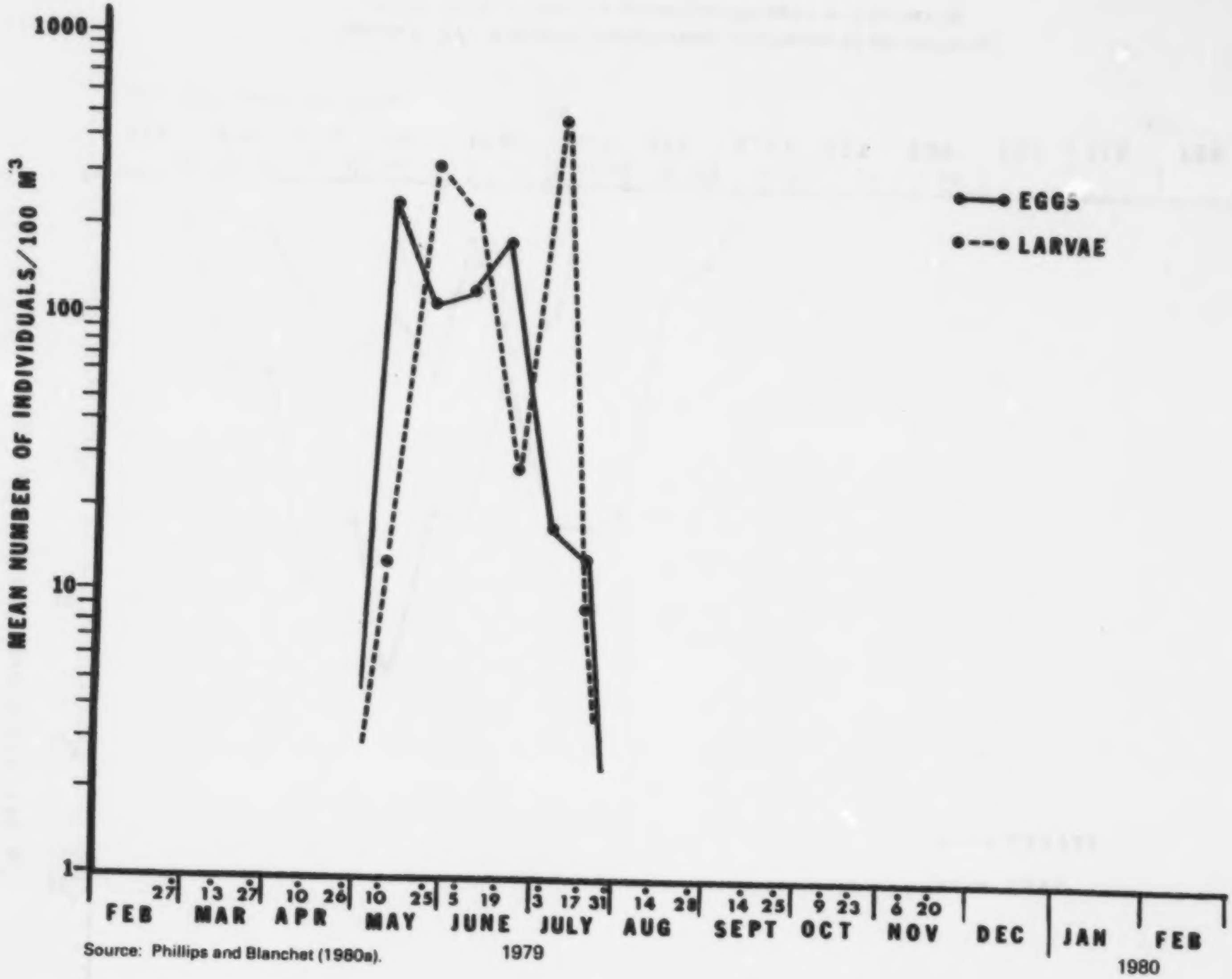
Source: Phillips and Blanchet (1980a).

Figure 5-26. Seasonal distribution (averages of all stations) of sciaenid eggs in the Big Bend area during 1979-1980.



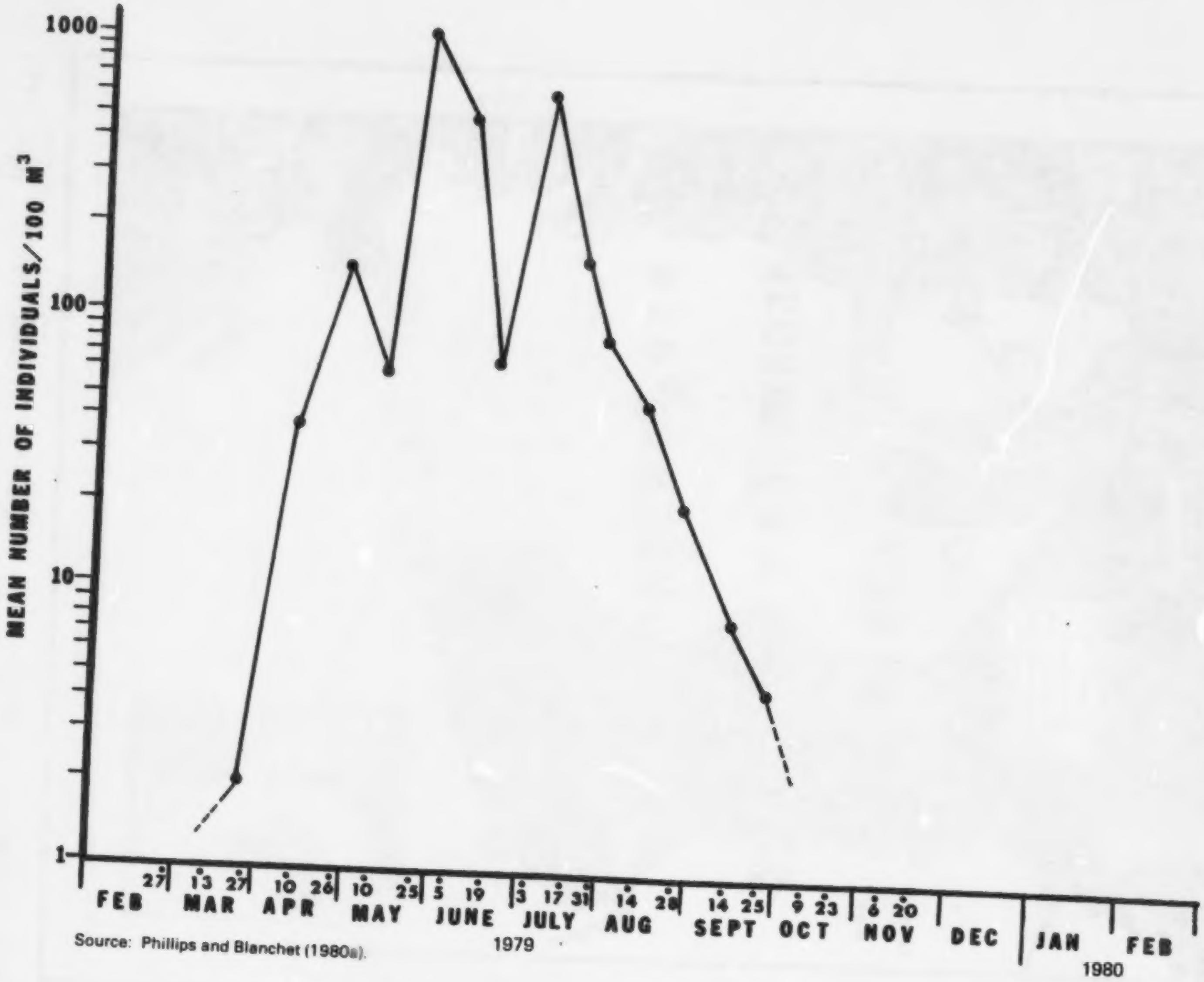
Source: Phillips and Blanchet (1980a).

Figure 5-27. Seasonal distribution (averages of all stations) of *Bairdiella chrysoura* (silver perch) eggs and larvae in the Big Bend area during 1979-1980.



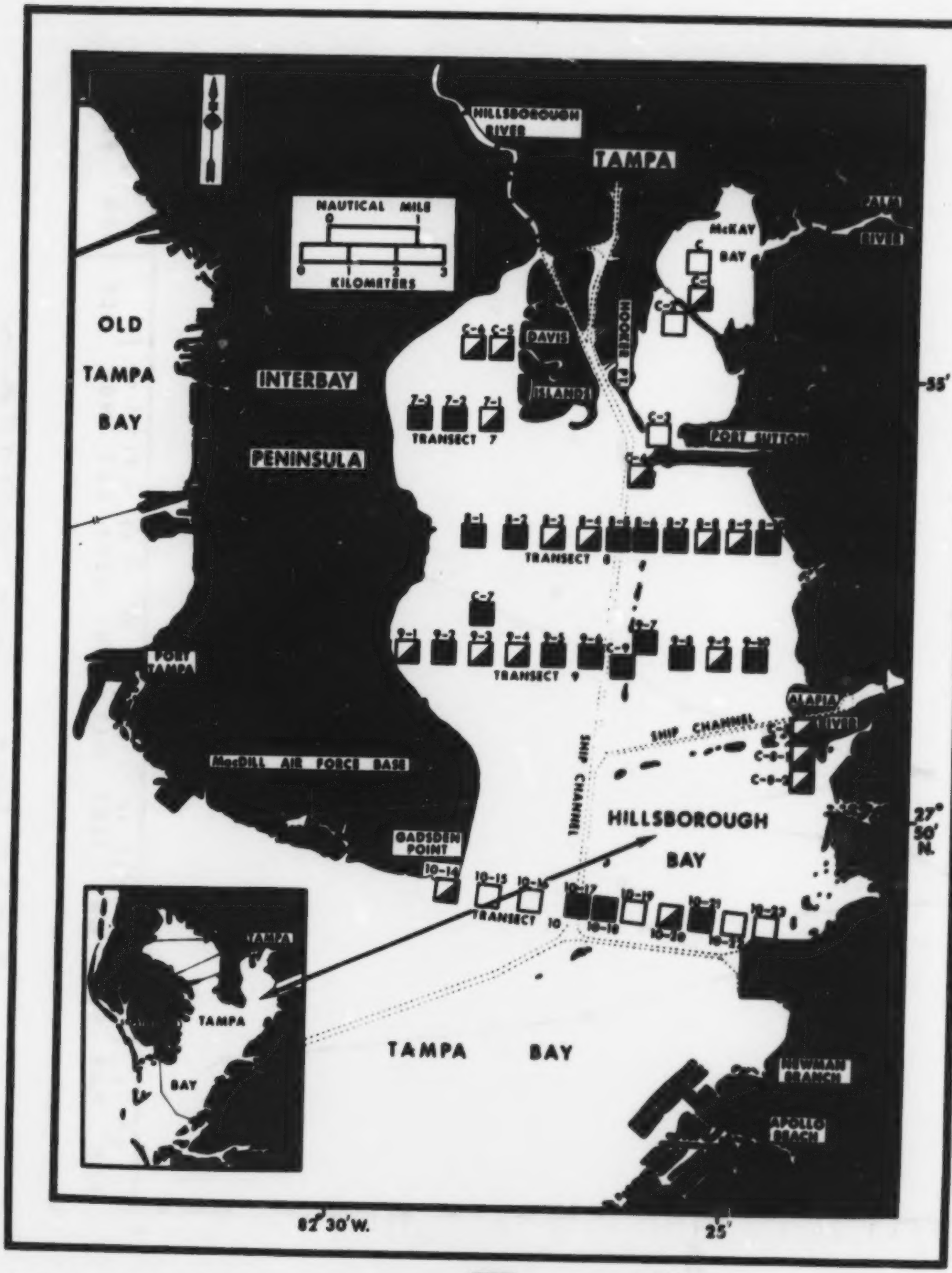
Source: Phillips and Blanchet (1980a).

Figure 5-28. Seasonal distribution (averages of all stations) of *Harengula jaguana* (scaled sardine) eggs and larvae in the Big Bend area during 1979-1980.



Source: Phillips and Blanchet (1980a).

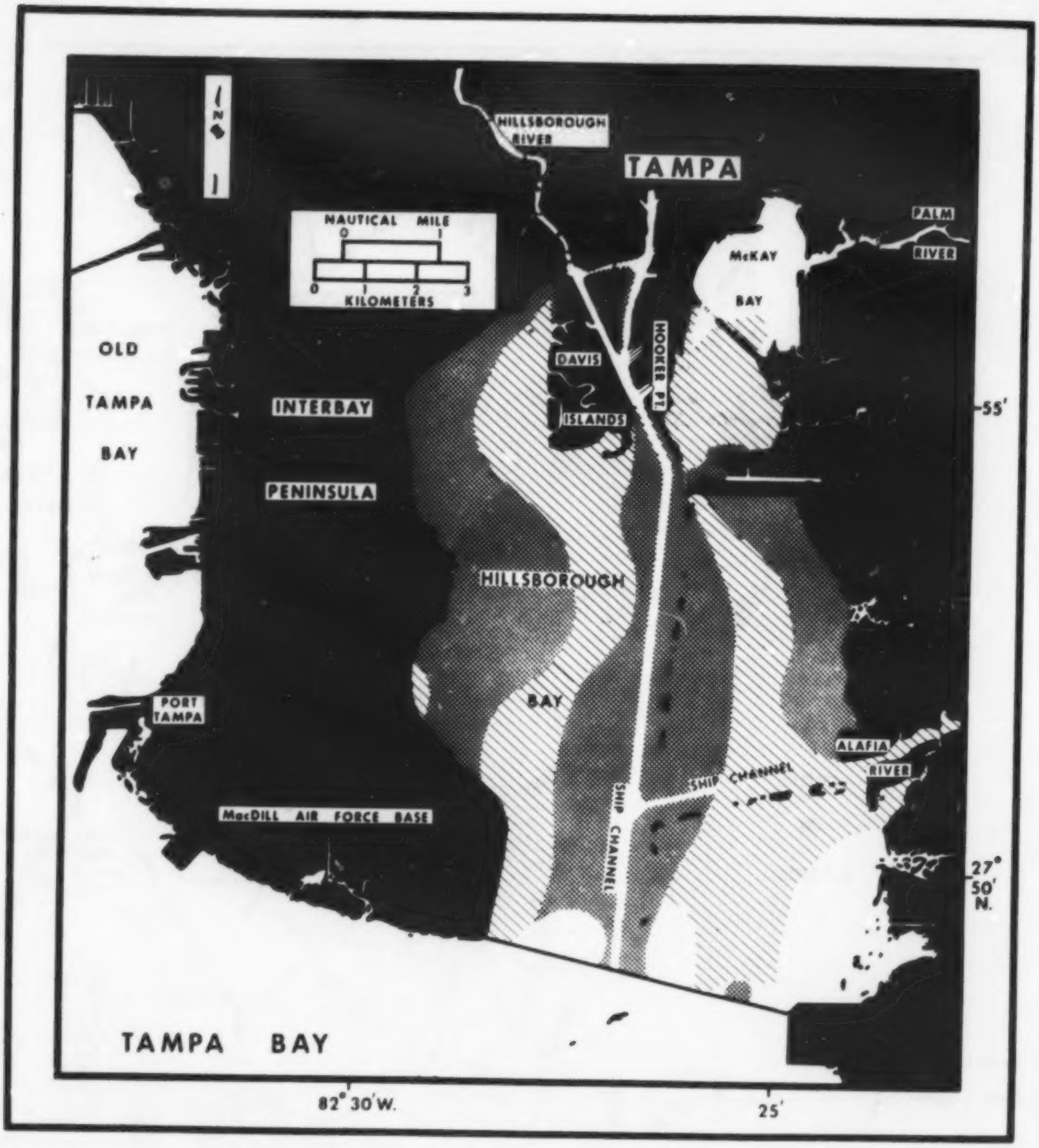
Figure 5-29. Seasonal distribution (averages of all stations) of *Menippe mercenaria* (stone crab) zoeae in the Big Bend area during 1979-1980.


HILLSBOROUGH RIVER
TAMPA
NAUTICAL MILE
0
1
0
1
2
3
KILOMETERS
OLD TAMPA BAY
INTERBAY
PENINSULA
McKAY BAY
PALM RIVER
C-6
C-5
DAVIS
ISLANDS
HOOKER PT.
7-3
7-2
7-1
TRANSECT 7
C-3
C-4
PORT SUTTON
55'
TRANSECT 8
C-7
TRANSECT 9
C-9
PORT TAMPA
MacDILL AIR FORCE BASE
ALAFIA
RIVER
SHIP CHANNEL
SHIP CHANNEL
HILLSBOROUGH
BAY
GADSDEN POINT
10-14
10-15
10-16
10-17
10-18
10-19
10-20
10-21
10-22
10-23
TRANSECT 10
27° 50' N.
TAMPA
TAMPA
BAY
TAMPA BAY
NEWMAN BRANCH
APOLLO BEACH
82° 30'W.
25'

Source: Taylor, Hall, and Saloman (1971).

■ Unhealthy ◩ Marginal ☐ Healthy

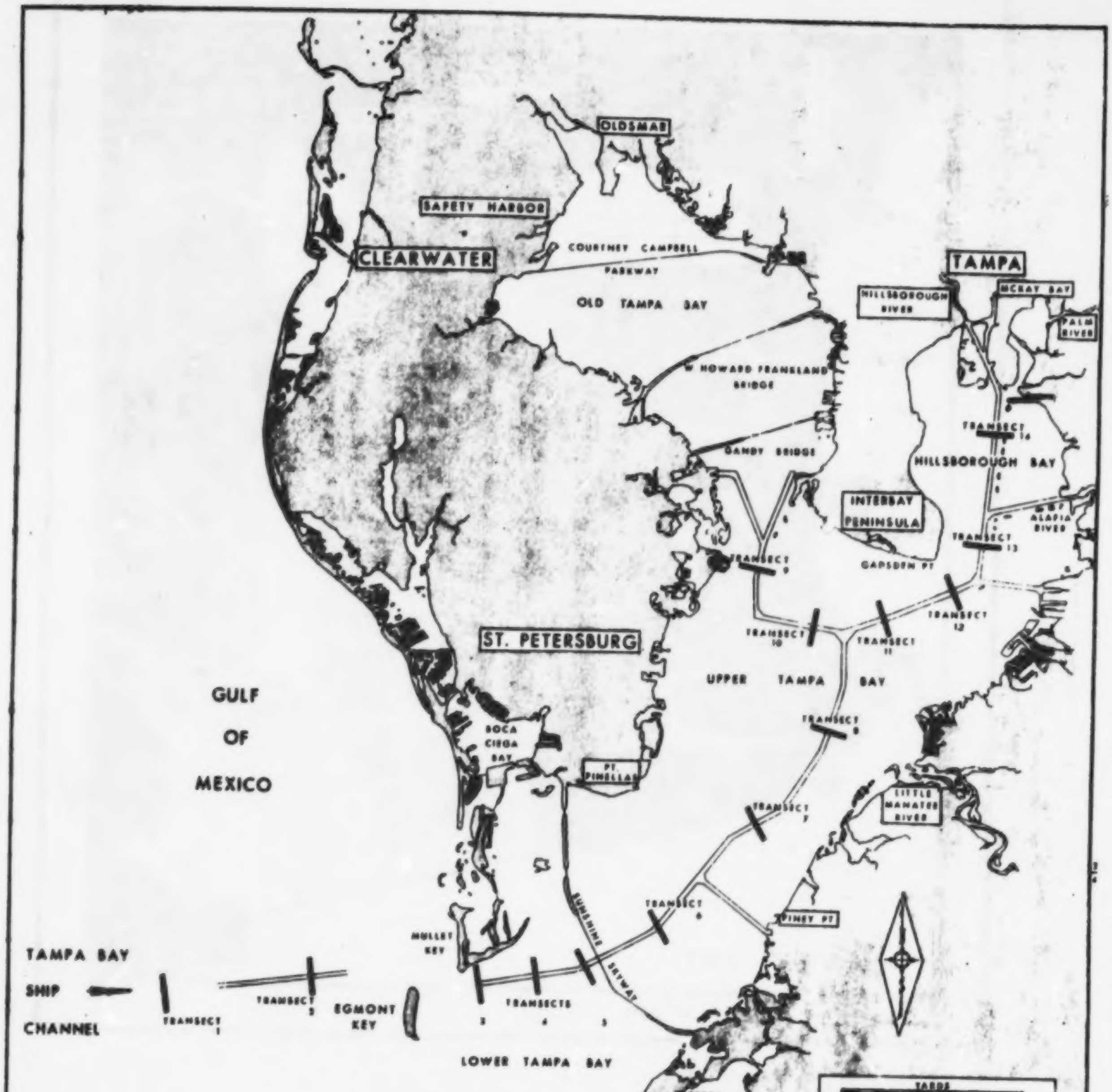
Figure 5-30. Sites of collection of benthic mollusks in Hillsborough Bay during August-September 1963.


N
HILLSBOROUGH RIVER
TAMPA
NAUTICAL MILE
0 1
0 1 2 3
KILOMETERS
PALM RIVER
McKAY BAY
OLD TAMPA BAY
INTERBAY
PENINSULA
DAVIS
ISLANDS
HOOKER PT.
55'
HILLSBOROUGH
BAY
PORT TAMPA
ALAFIA
RIVER
SHIP CHANNEL
SHIP CHANNEL
MacDILL AIR FORCE BASE
27° 50' N.
TAMPA BAY
82° 30'W.
25'

Source: Taylor, Hall, and Saloman (1971).

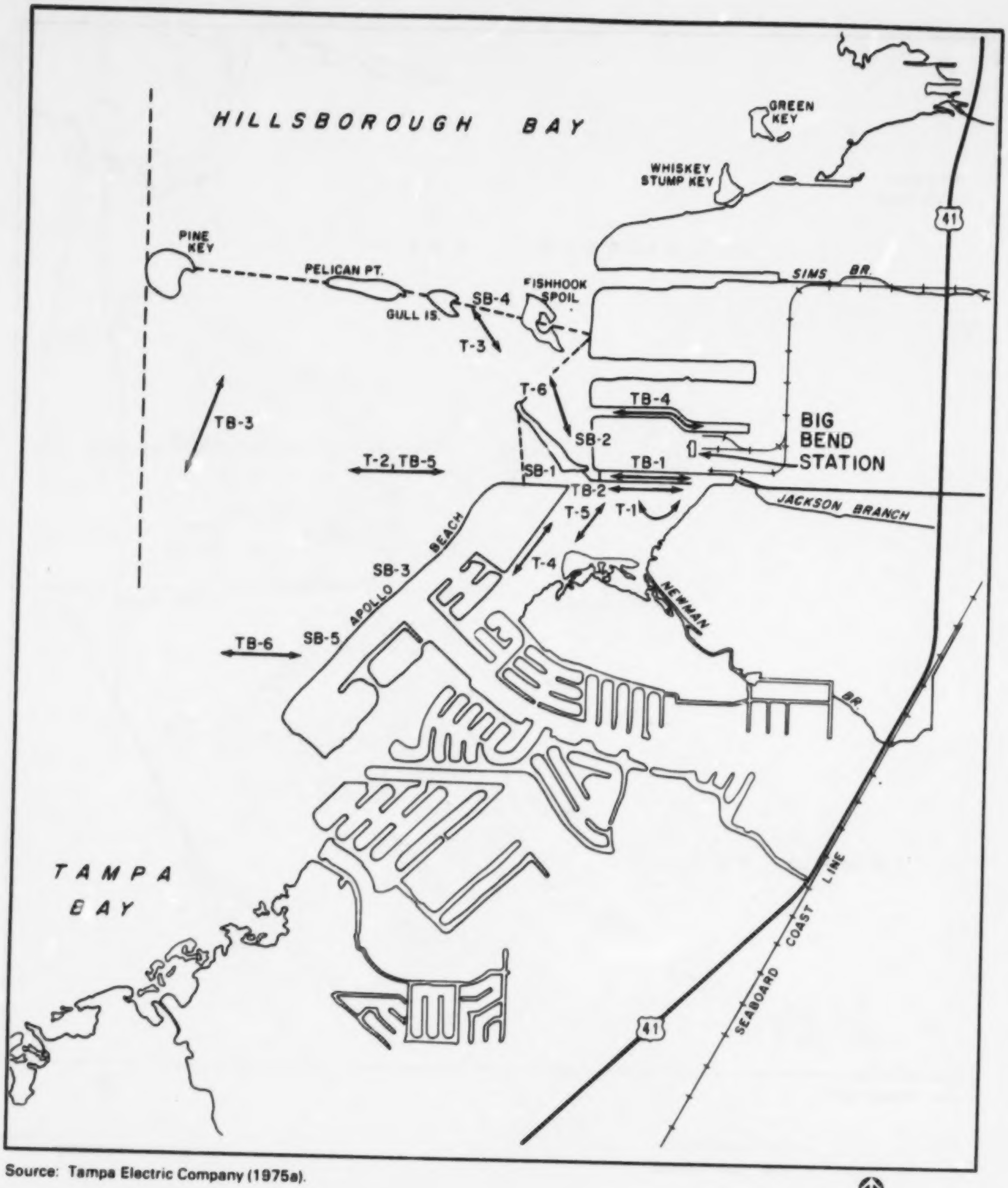
■ Unhealthy ▨ Marginal ☐ Healthy

Figure 5-31. Ecological zones in Hillsborough Bay based on the comparative diversity of benthic mollusks during August-September 1963.


OLDSMAR
SAFETY HARBOR
CLEARWATER
COURTNEY CAMPBELL PARKWAY
OLD TAMPA BAY
W HOWARD FRANKLAND BRIDGE
GANDY BRIDGE
TAMPA
HILLSBOROUGH RIVER
MCKAY BAY
PALM RIVER
TRANSECT 14
HILLSBOROUGH BAY
INTERBAY PENINSULA
ALAFIA RIVER
TRANSECT 13
GADSDEN PT
TRANSECT 9
TRANSECT 12
TRANSECT 10
TRANSECT 11
ST. PETERSBURG
UPPER TAMPA BAY
GULF OF MEXICO
TRANSECT 8
BOCA CIEGA BAY
PT. PINELLAS
LITTLE MANATEE RIVER
TRANSECT 7
TRANSECT 6
PINEY PT
SUNSHINE SKYWAY
MULLET KEY
TAMPA BAY SHIP CHANNEL
TRANSECT 1
TRANSECT 2
EGMONT KEY
TRANSECTS 3 4 5
LOWER TAMPA BAY
YARDS
1000 0 1 2 3 4 5000 10000
TERRA CEIA BAY
ANNA MARIA KEY
PALMETTO
MANATEE RIVER
BRADENTON
82° 30'
82° 30'

Source: U.S. Army Corps of Engineers (1974b).

Figure 5-32. Benthic invertebrate sampling transects along the main ship channel in Tampa Bay, March-April 1973.



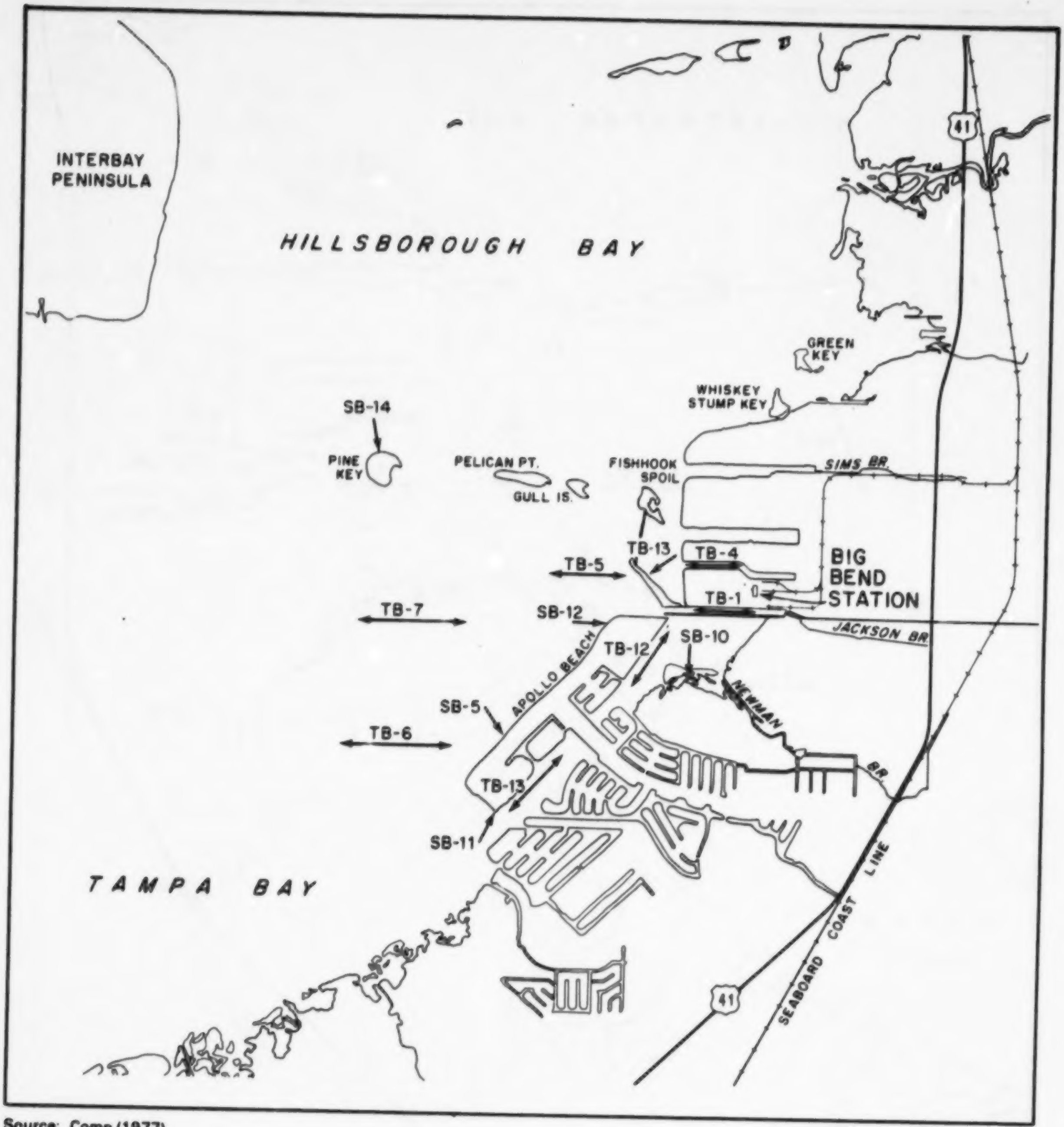
HILLSBOROUGH BAY
GREEN KEY
WHISKEY STUMP KEY
41
PINE KEY
PELICAN PT.
GULL IS.
SB-4
FISHHOOK SPOIL
SIMS BR.
T-3
T-6
TB-3
TB-4
SB-2
BIG BEND STATION
T-2, TB-5
SB-1
TB-1
TB-2
JACKSON BRANCH
T-5
T-1
T-4
BEACH
SB-3
APOLLO
NEWMAN
BR.
TB-6
SB-5
TAMPA BAY
LINE
COAST
SEABOARD
41

Source: Tampa Electric Company (1975a).

SB Seine Station
TB Trawl Station

0 1 2 Miles

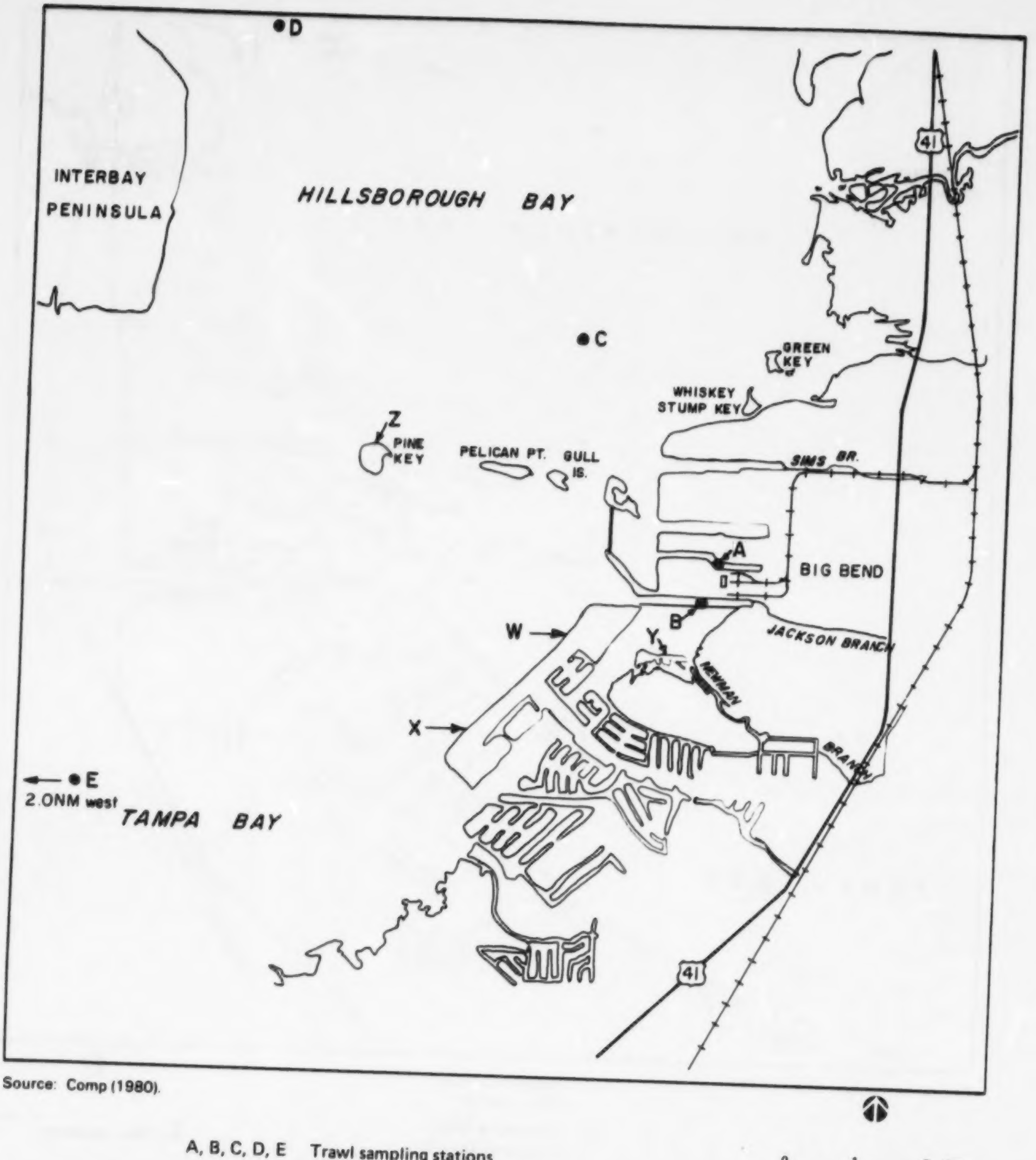
Figure 5-33. Seine and trawl sampling stations at Big Bend, 1970-1975.


INTERBAY PENINSULA
HILLSBOROUGH BAY
41
GREEN KEY
WHISKEY STUMP KEY
SB-14
PINE KEY
PELICAN PT.
GULL IS.
FISHHOOK SPOIL
SIMS BR.
TB-13
TB-4
TB-5
BIG BEND STATION
TB-1
TB-7
SB-12
JACKSON BR
TB-12
SB-10
APOLLO BEACH
NEWMAN BR.
SB-5
TB-6
TB-13
SB-11
TAMPA BAY
SEABOARD COAST LINE
41
0
1
2 Miles

Source: Comp (1977).

SB Seine Station
TB Trawl Station

Figure 5-34. Seine and trawl sampling stations at Big Bend, January 1976-March 1977.

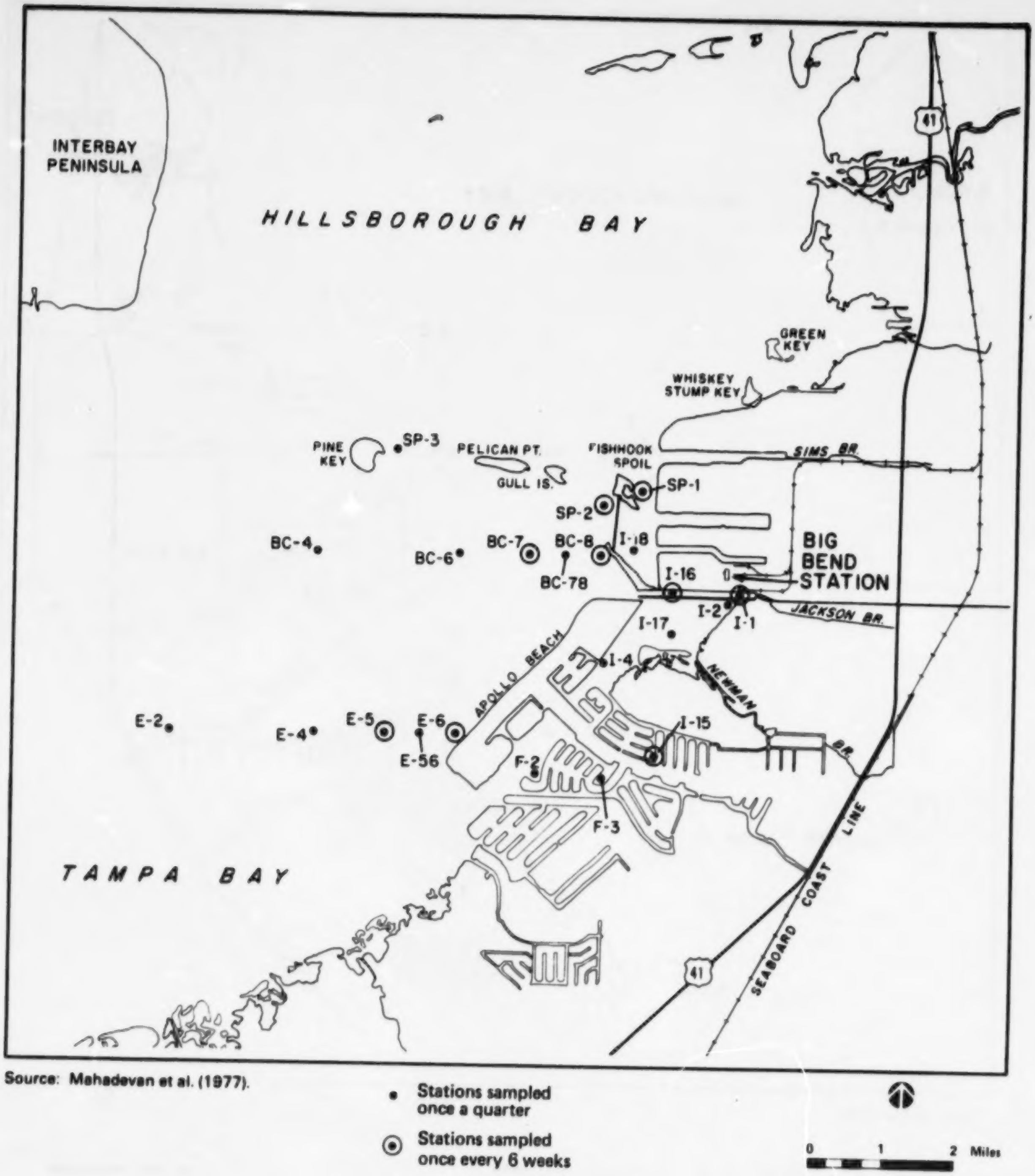


D
INTERBAY
PENINSULA
HILLSBOROUGH BAY
41
C
GREEN
KEY
WHISKEY
STUMP KEY
Z
PINE
KEY
PELICAN PT.
GULL
IS.
SIMS BR.
A
BIG BEND
B
W
JACKSON BRANCH
Y
NEWMAN
X
BRANCH
E
2.0NM west
TAMPA BAY
41
0
1
2
Miles

Source: Comp (1980).

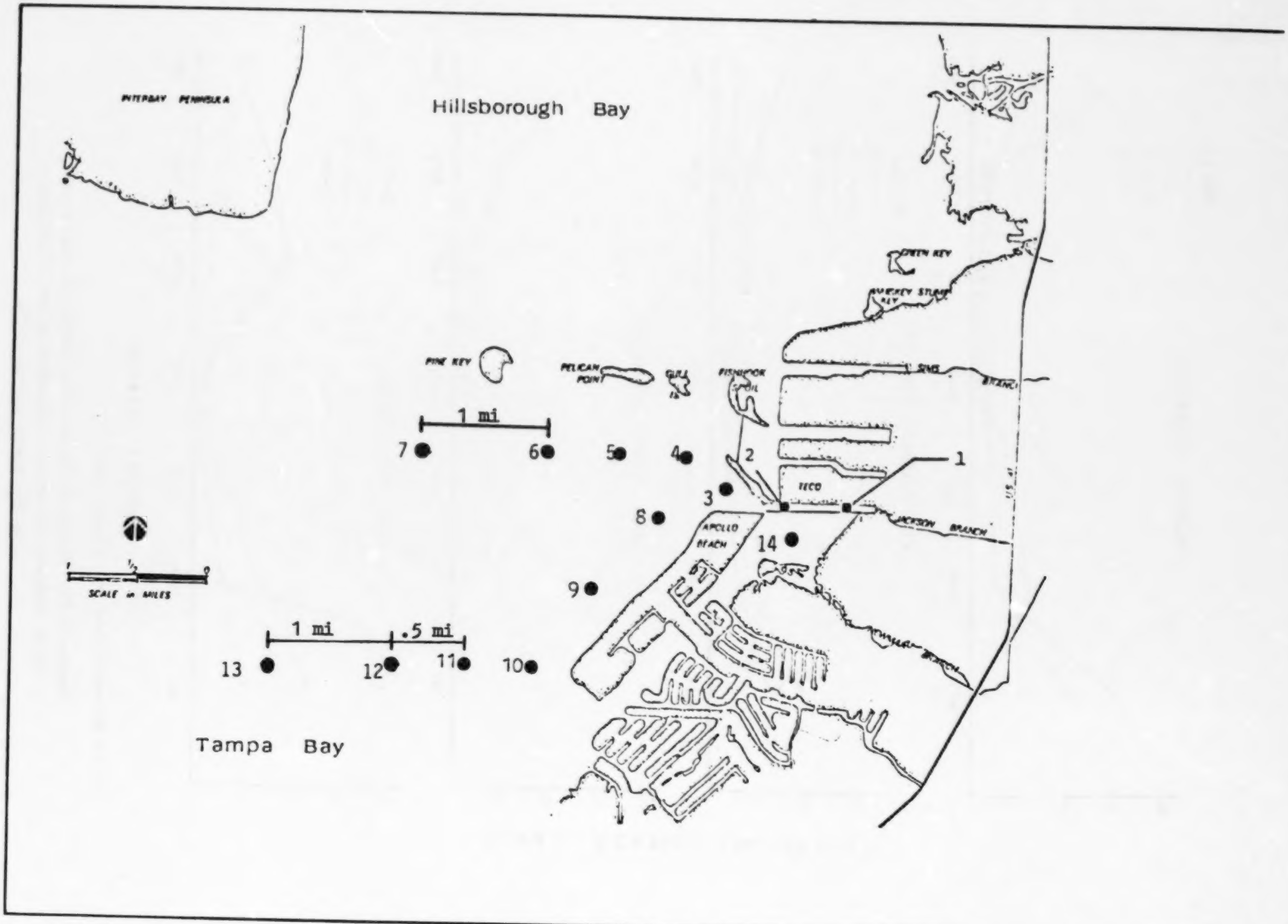
A, B, C, D, E Trawl sampling stations
W, X, Y, Z Seine sampling stations

Figure 5-35. Seine and trawl sampling stations at Big Bend, March 1979-January 1980.


INTERBAY PENINSULA
HILLSBOROUGH BAY
TAMPA BAY
41
GREEN KEY
WHISKEY STUMP KEY
PINE KEY
SP-3
PELICAN PT.
GULL IS.
FISHHOOK SPOIL
SP-1
SP-2
SIMS BR.
BC-4
BC-6
BC-7
BC-8
BC-78
I-18
I-16
BIG BEND STATION
I-2
I-1
JACKSON BR.
I-17
I-4
APOLLO BEACH
NEWMAN BR.
I-15
E-2
E-4
E-5
E-6
E-56
F-2
F-3
SEABOARD COAST LINE
41
Stations sampled once a quarter
Stations sampled once every 6 weeks
0
1
2 Miles

Source: Mahadevan et al. (1977).

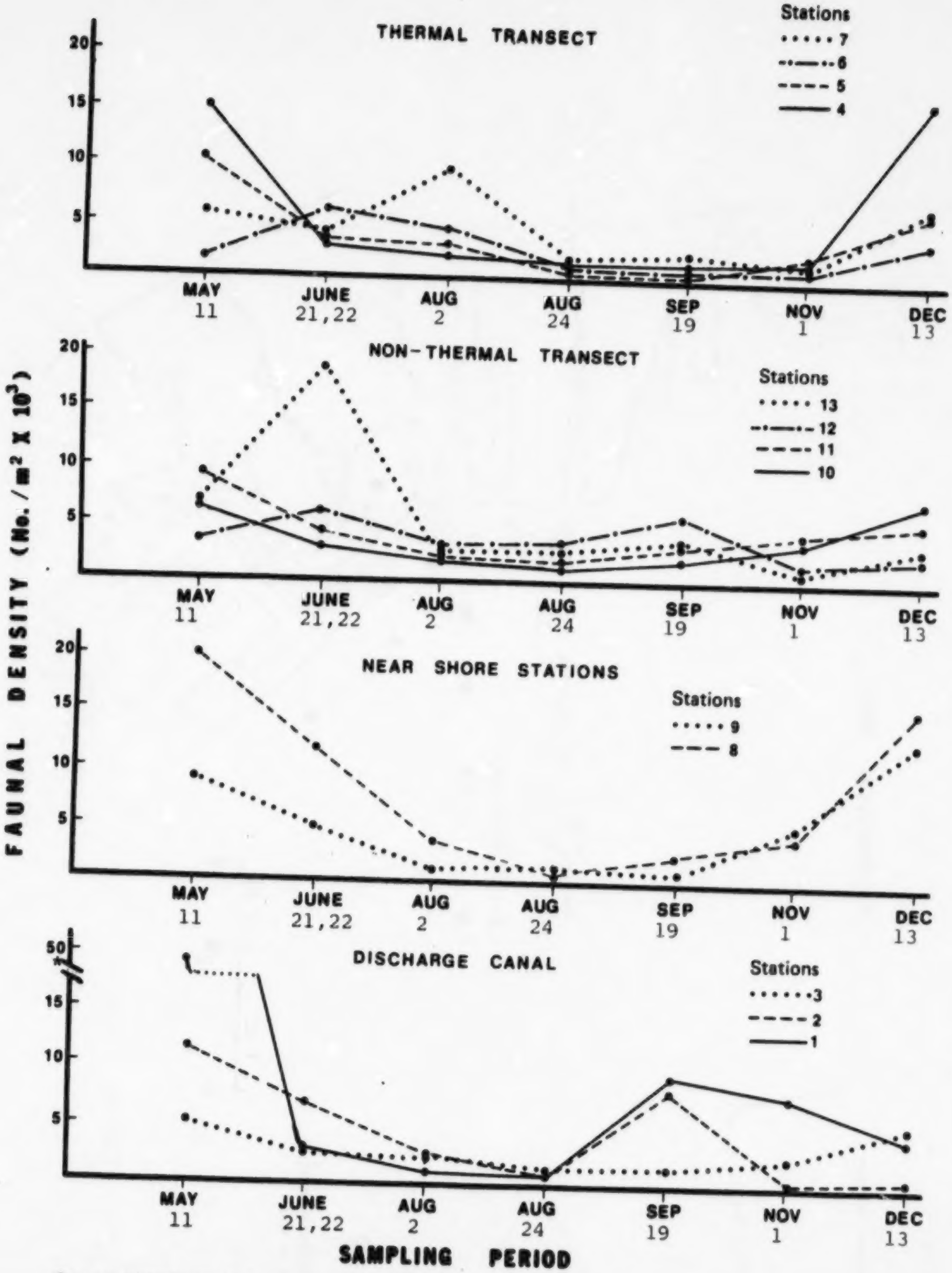
Figure 5-36. Benthic invertebrate sampling stations at Big Bend, February 1976-February 1977.



INTERBAY PENINSULA
Hillsborough Bay
PINE KEY
PELICAN POINT
GULL IS
FISHHOOK SPOIL
GREEN KEY
WHISKEY STUMP KEY
SIMS BRANCH
TECO
APOLLO BEACH
JACKSON BRANCH
U.S. 41
1 mi
.5 mi
1
2
3
4
5
6
7
8
9
10
11
12
13
14
SCALE in MILES
1
1/2
0
Tampa Bay

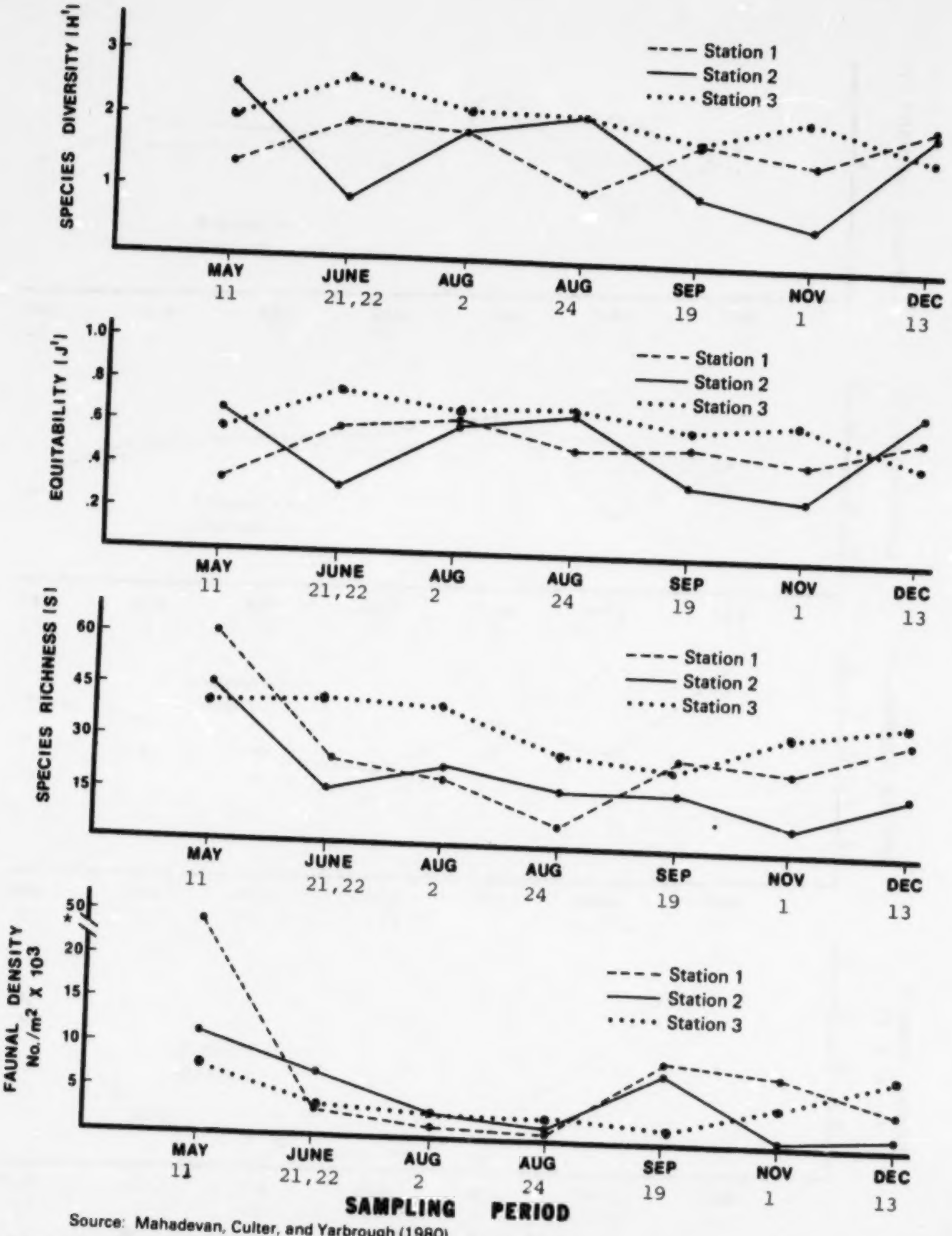
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-37. Benthic invertebrate sampling stations at Big Bend, May-December 1979.



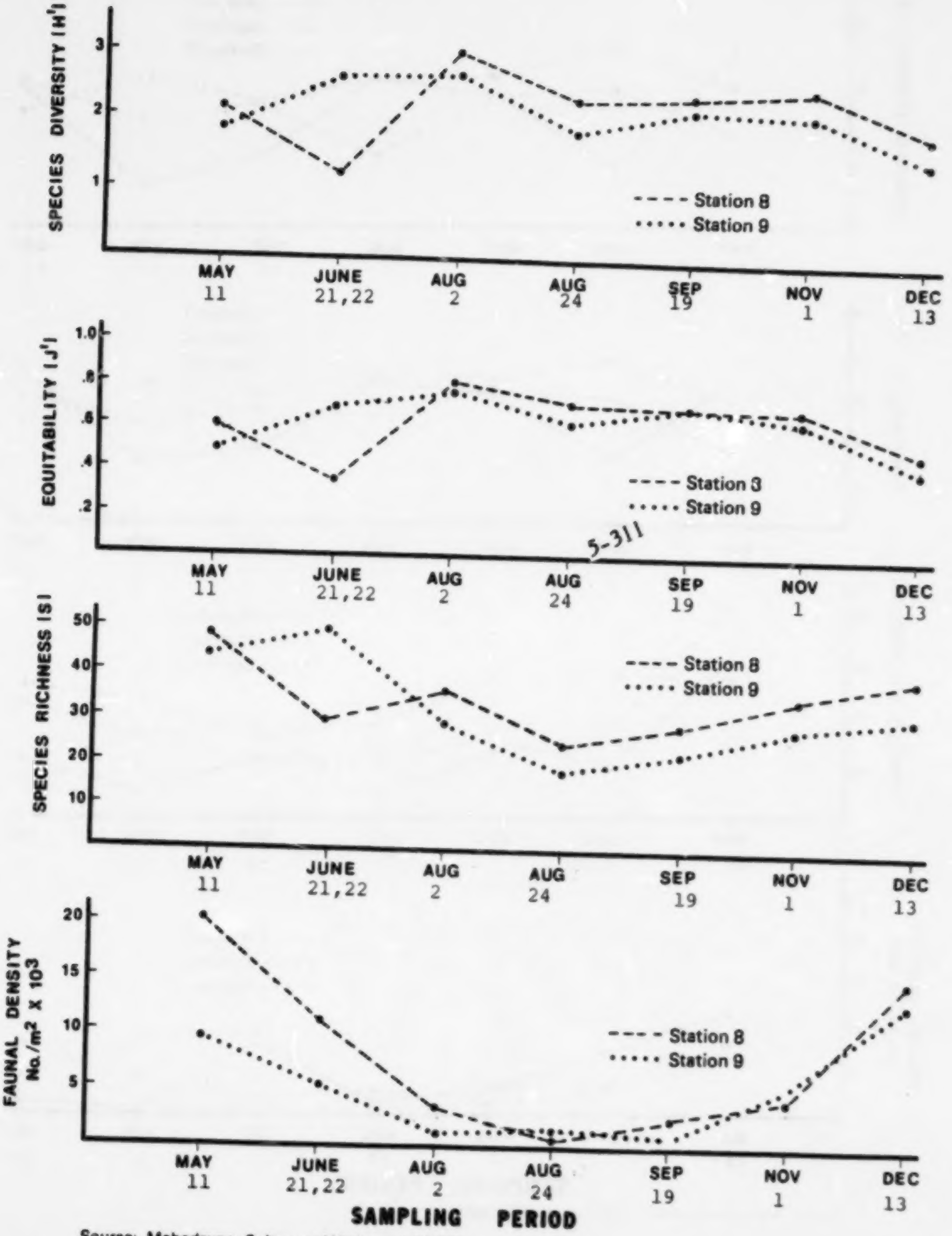
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-38. Seasonal variation of benthic faunal density (total number of benthic invertebrates) at 13 stations near Big Bend during 1979.



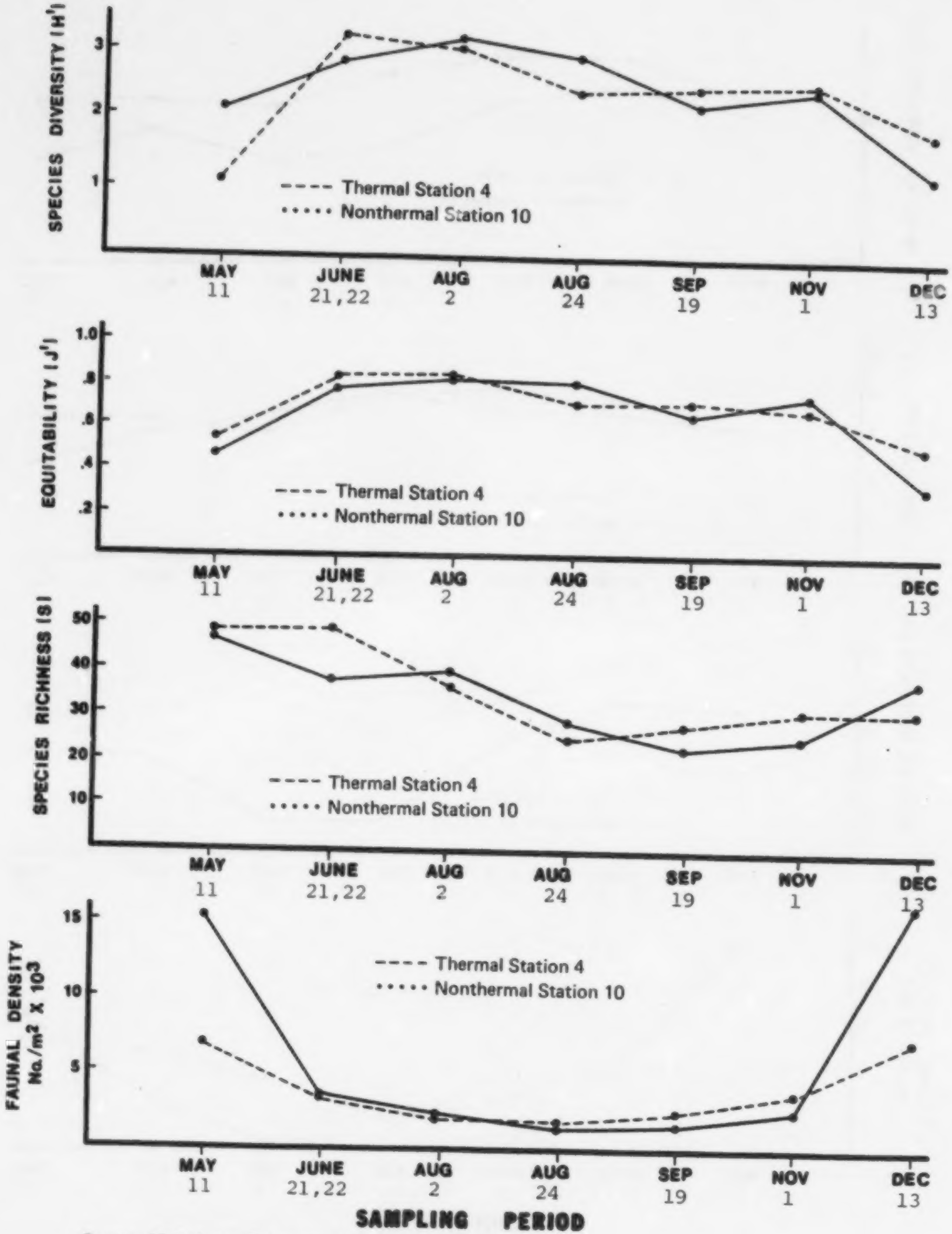
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-39. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963),equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at Stations 1, 2, and 3 in the area of the discharge canal of the Big Bend Powerplant during 1979.



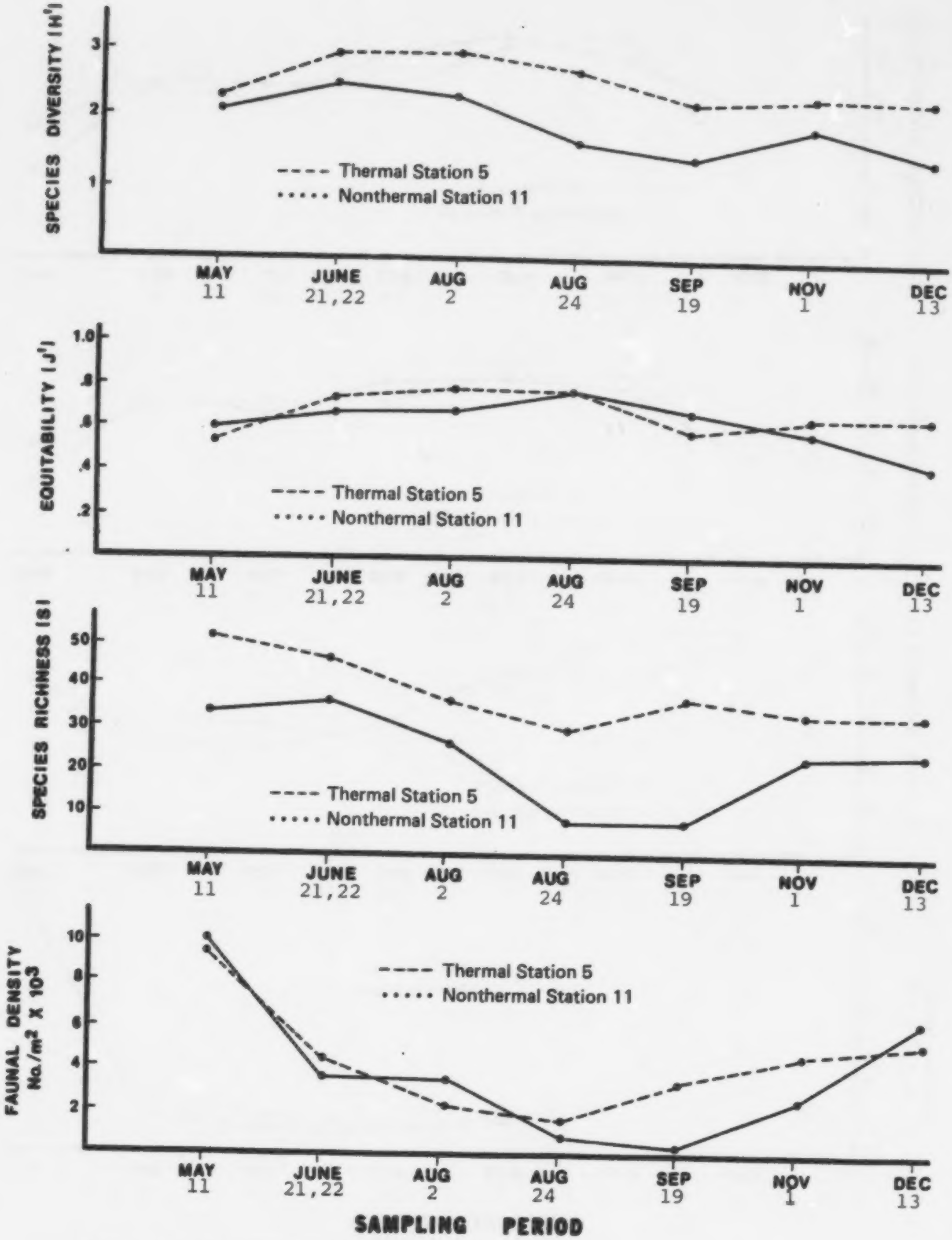
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-40. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at Stations 8 and 9 near Big Bend during 1979.



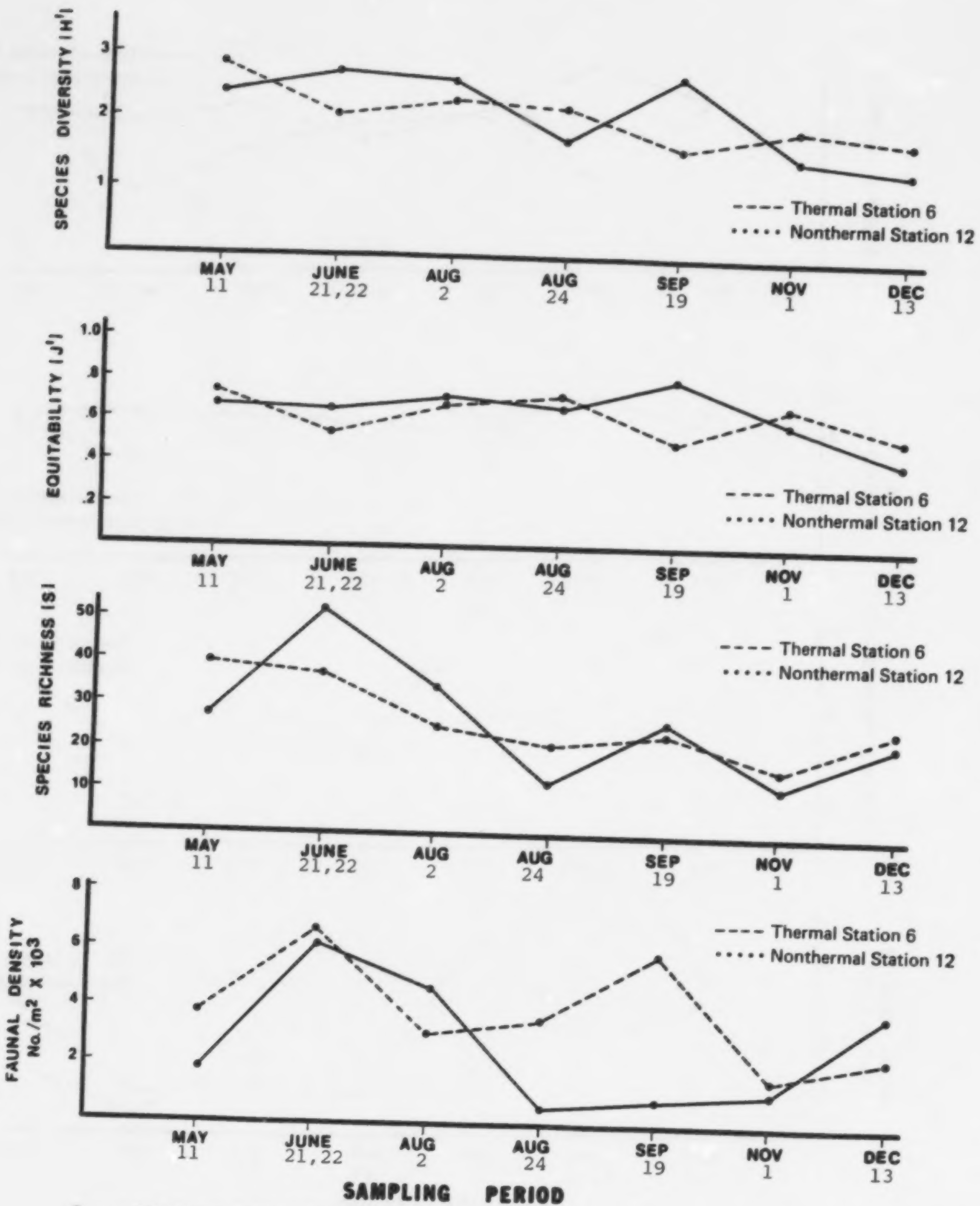
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-41. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal Station 4 and nonthermal Station 10 near Big Bend during 1979.



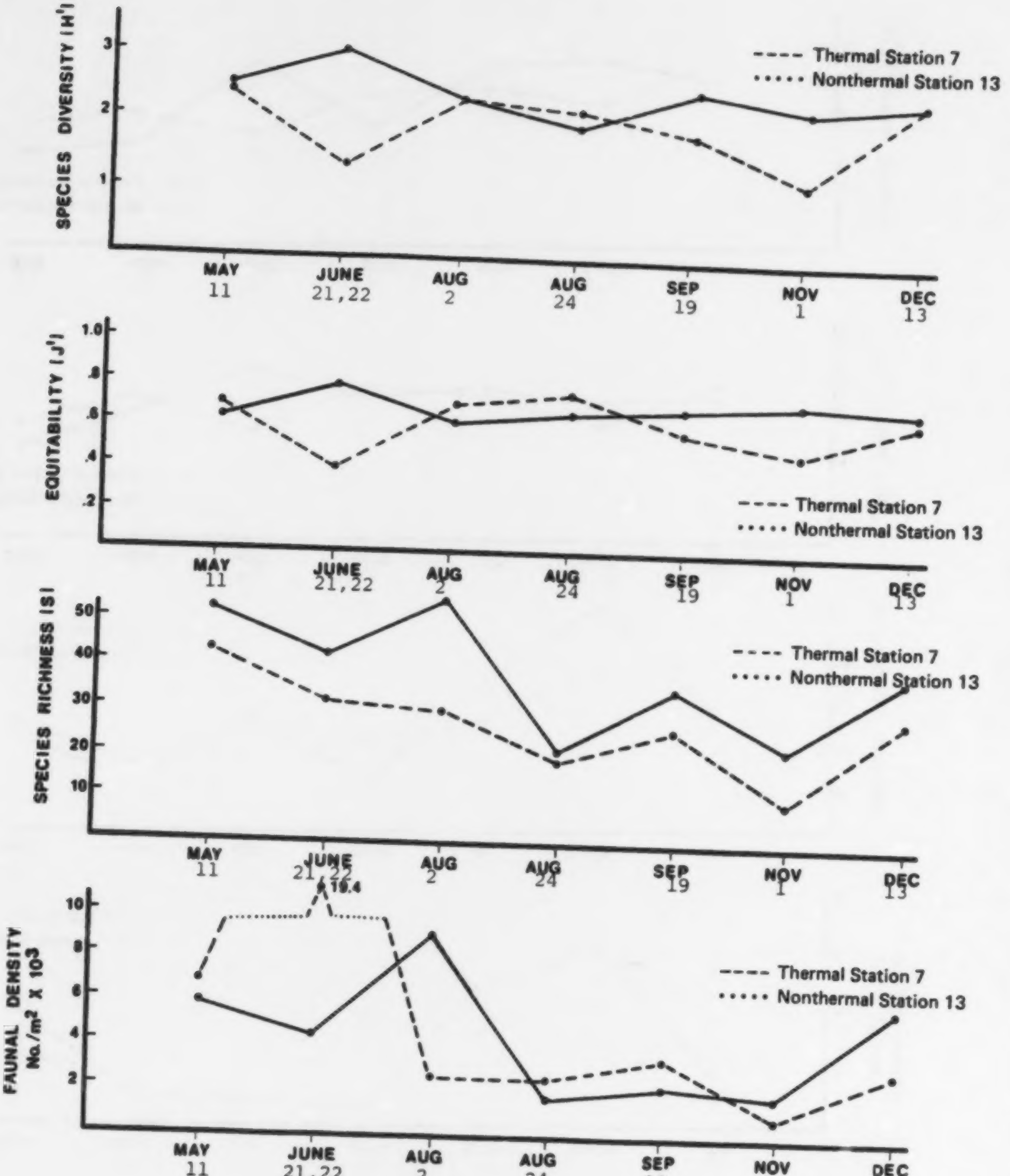
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-42. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal Station 5 and nonthermal Station 11 near Big Bend during 1979.



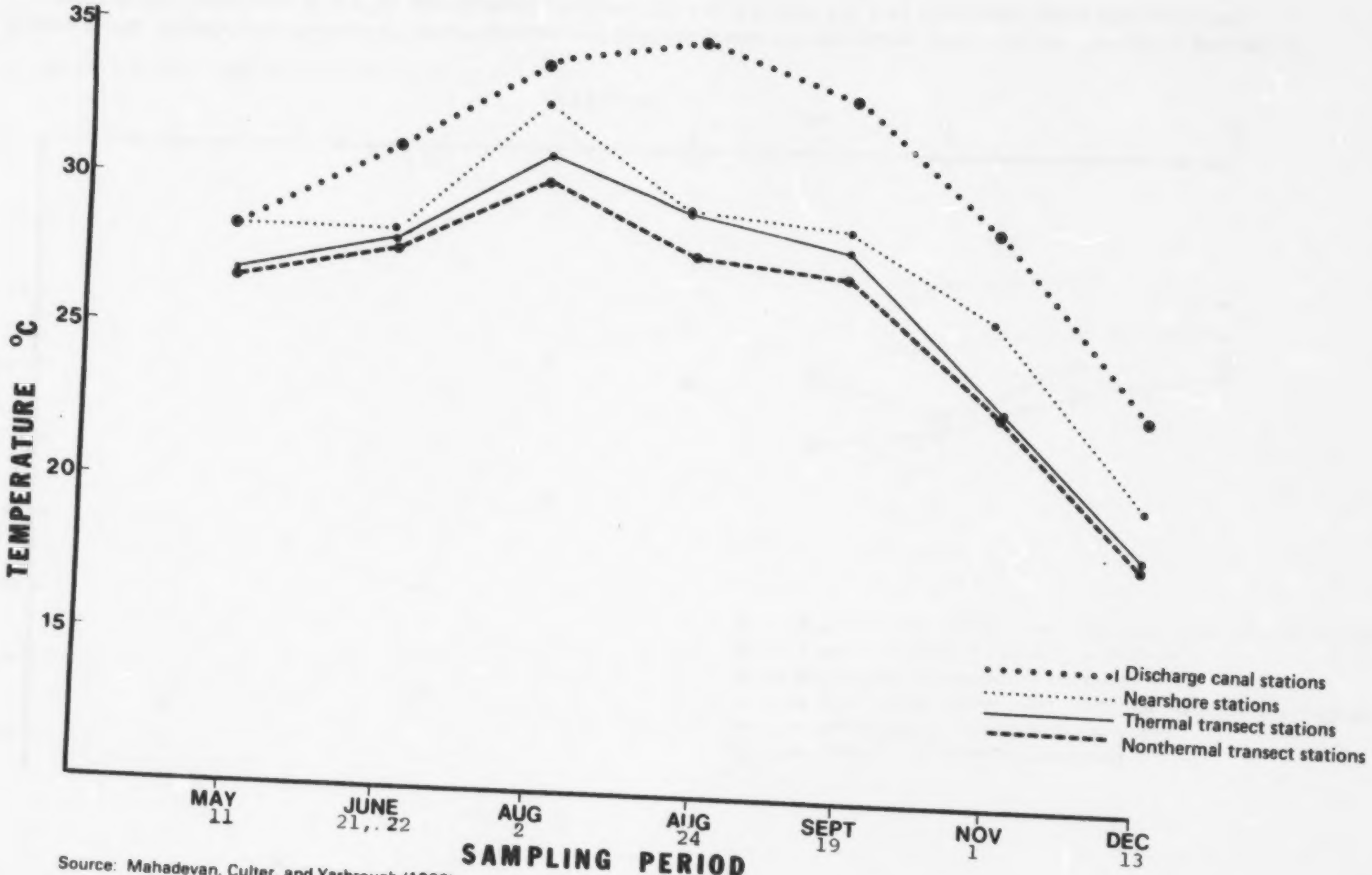
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-43. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal Station 6 and nonthermal Station 12 near Big Bend during 1979.



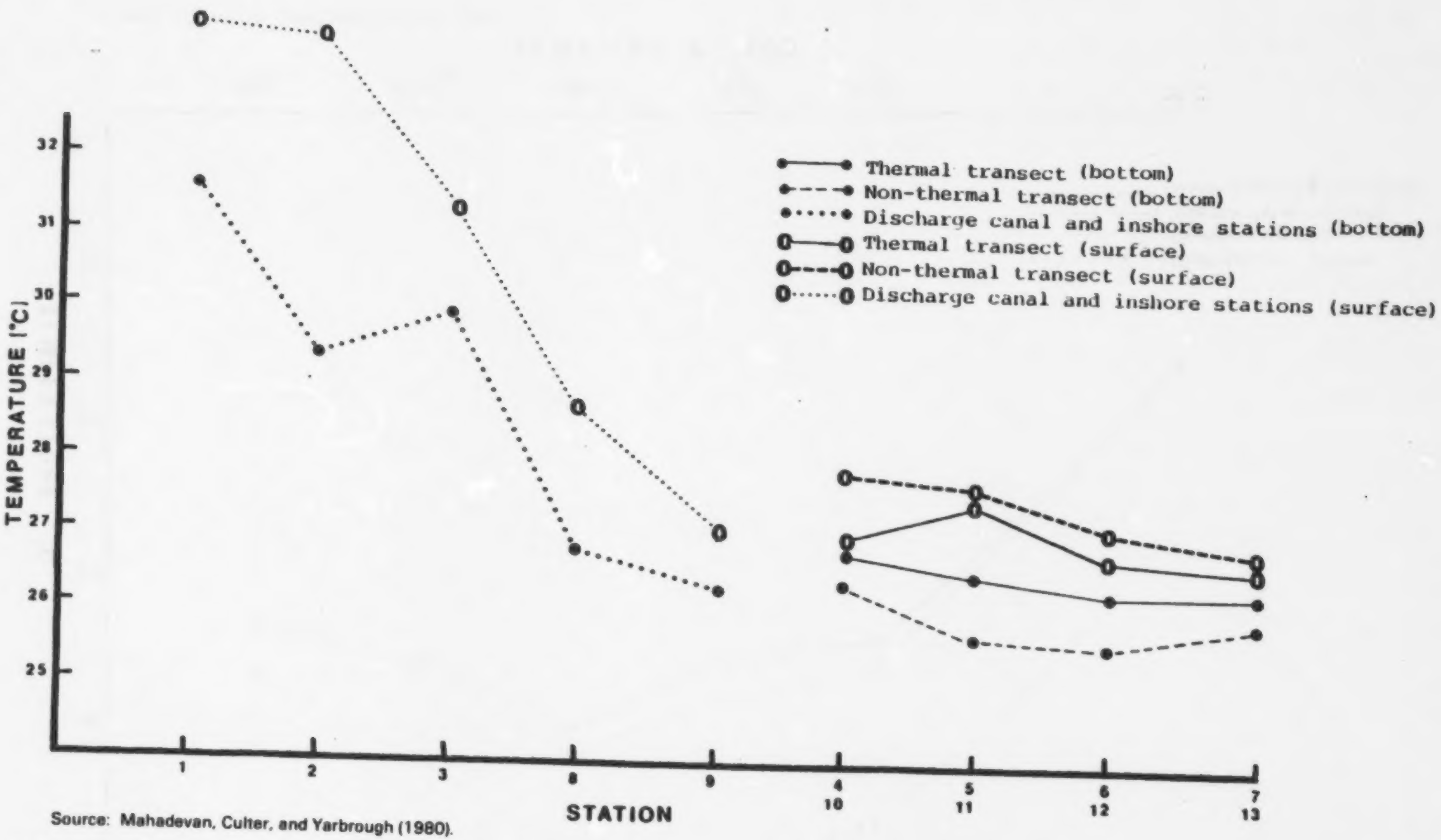
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-44. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal Station 7 and nonthermal Station 13 near Big Bend during 1979.



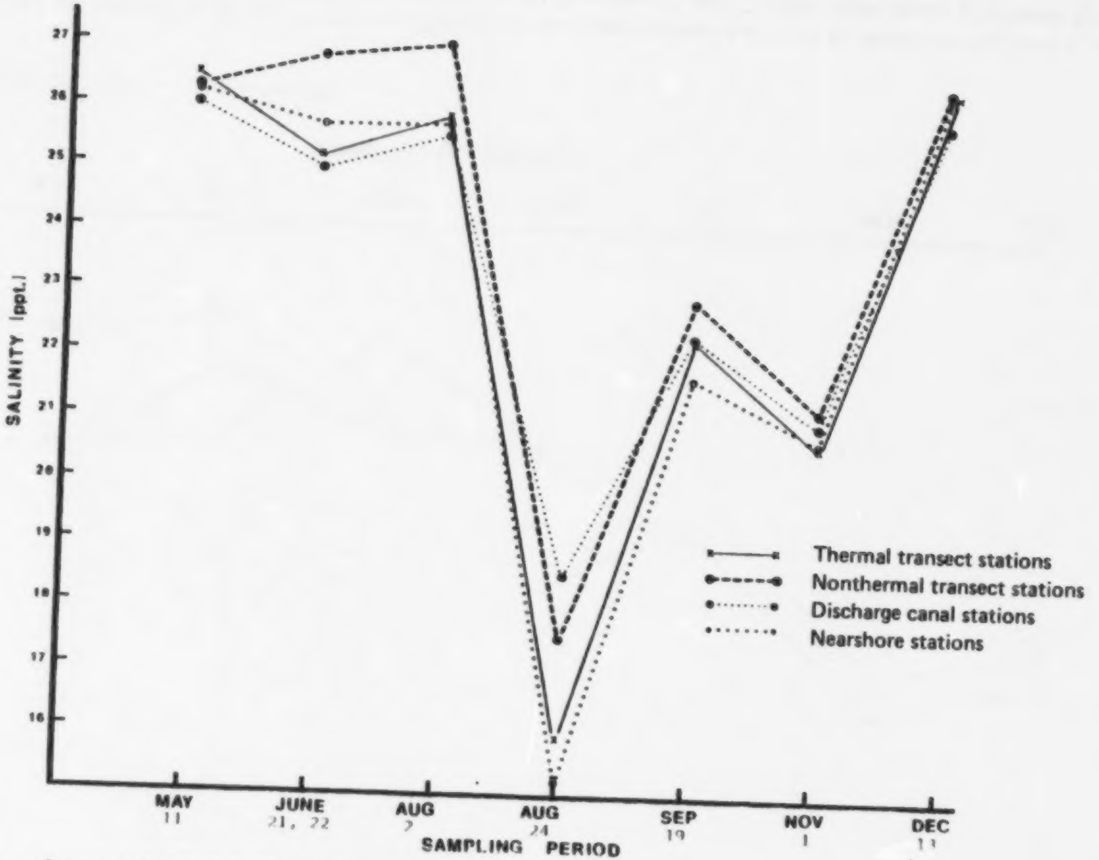
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-45. Seasonal variation of mean bottom water temperatures at thermal stations 4, 5, 6, and 7, nonthermal stations 10, 11, 12, and 13, discharge canal stations 1 and 2 and nearshore Stations 3, 8, and 9 near Big Bend during 1979.



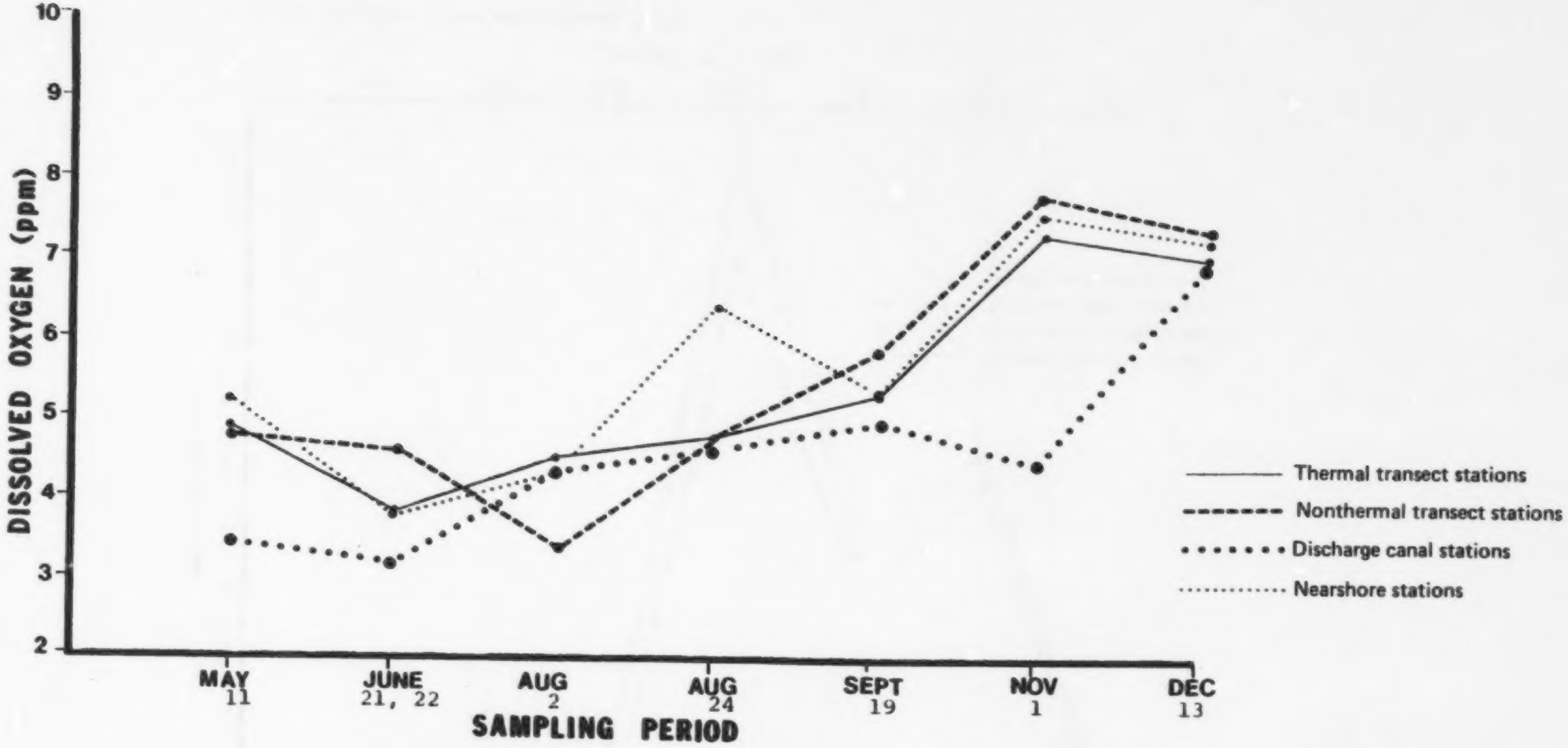
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-46. Spatial distribution of mean surface and bottom water temperatures (averages for the study period) at thermal Stations 4, 5, 6, and 7, nonthermal Stations 10, 11, 12, and 13, and discharge canal and nearshore Stations 1, 2, 3, 8, and 9 near Big Bend during 1979.



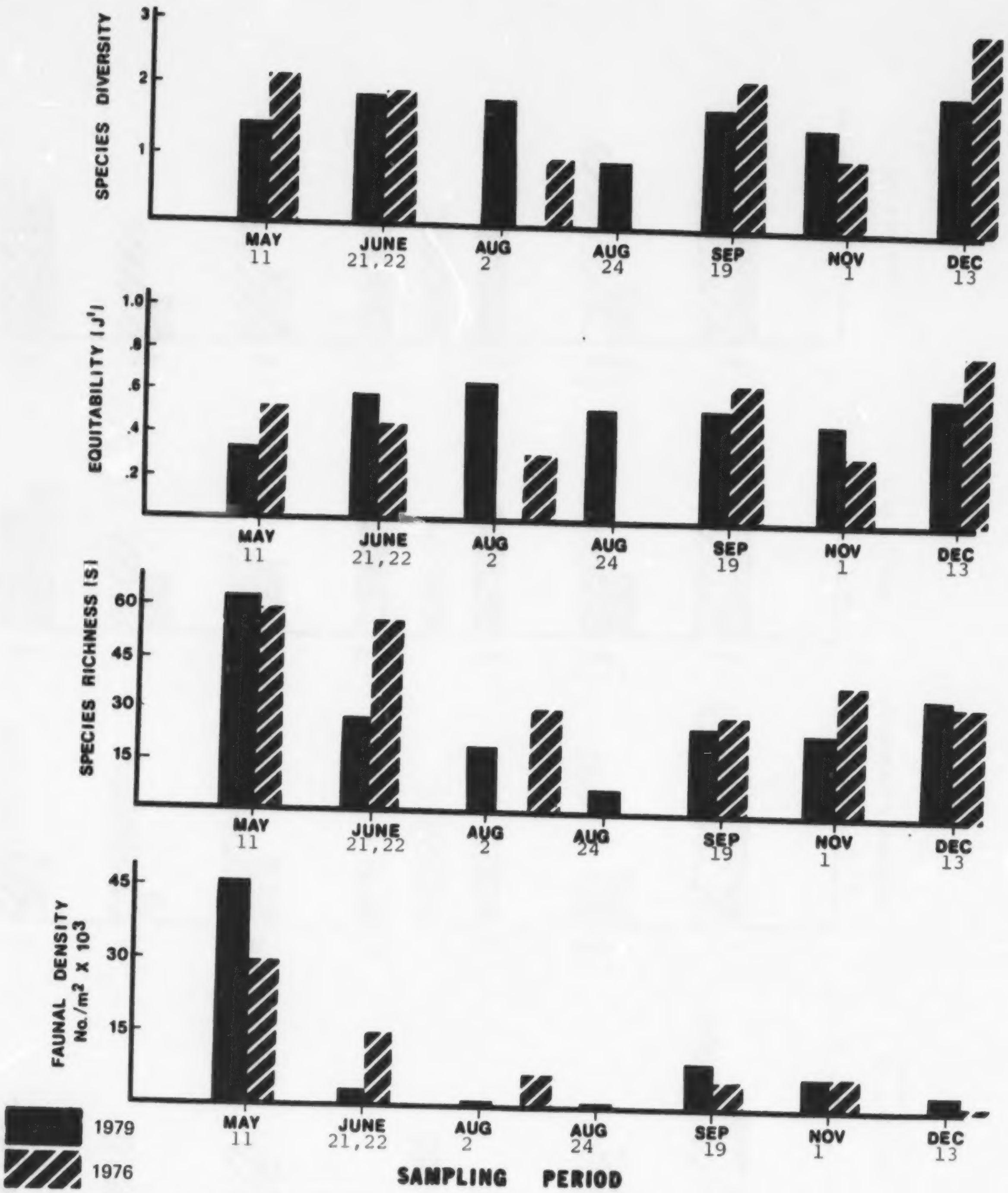
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-47. Seasonal variation of near bottom salinities at thermal Stations 4, 5, 6, and 7, nonthermal Stations 10, 11, 12, and 13, discharge canal stations 1 and 2, and nearshore Stations 3, 8, and 9 near Big Bend during 1979.



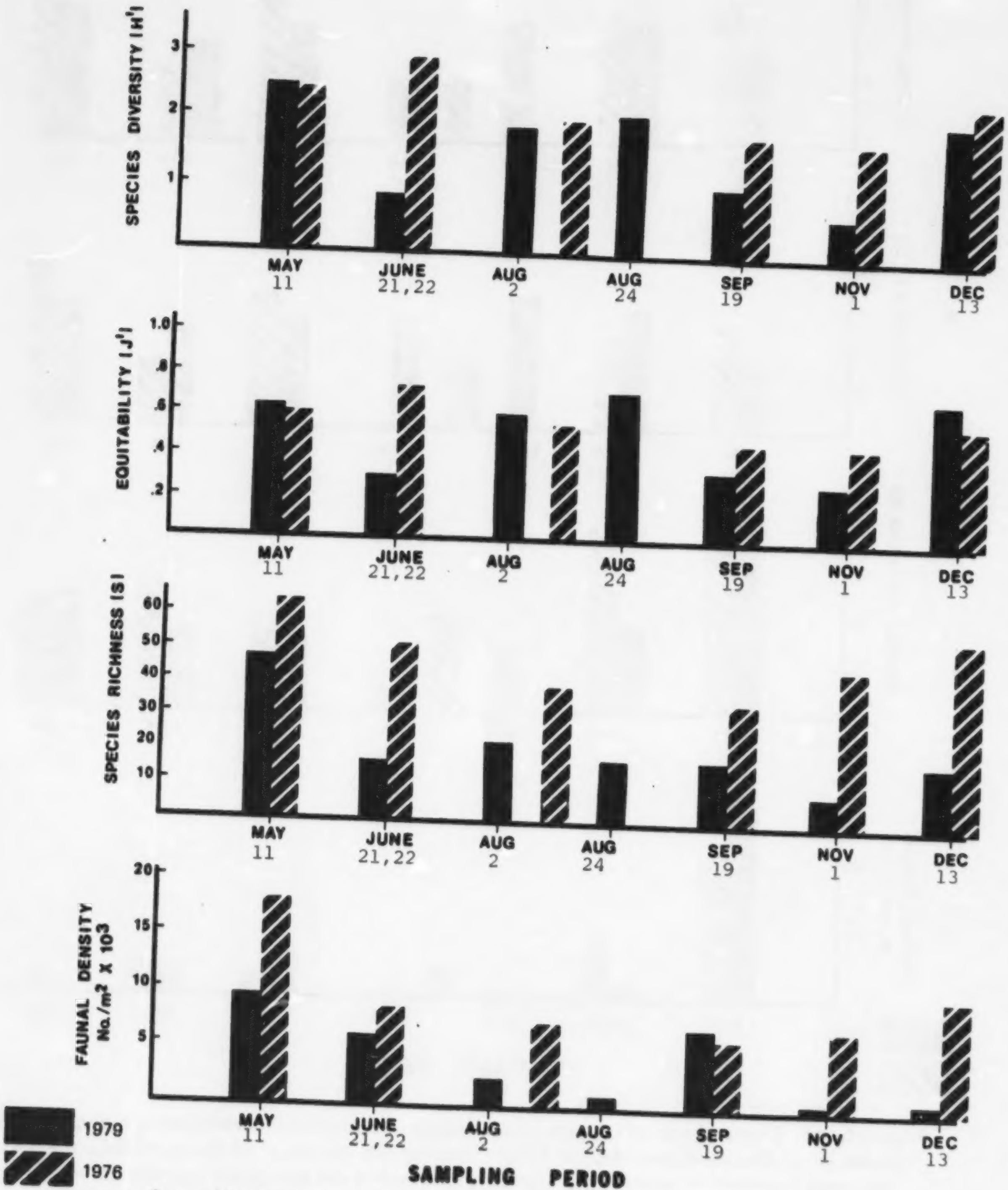
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-48. Seasonal variation of mean bottom dissolved oxygen concentrations at thermal stations 4, 5, 6, and 7, nonthermal Stations 10, 11, 12, and 13, discharge canal Stations 1 and 2, and nearshore Stations 3, 8, and 9 near Big Bend during 1979.



Source: Mahadevan, Culter, and Yarbrough (1980).

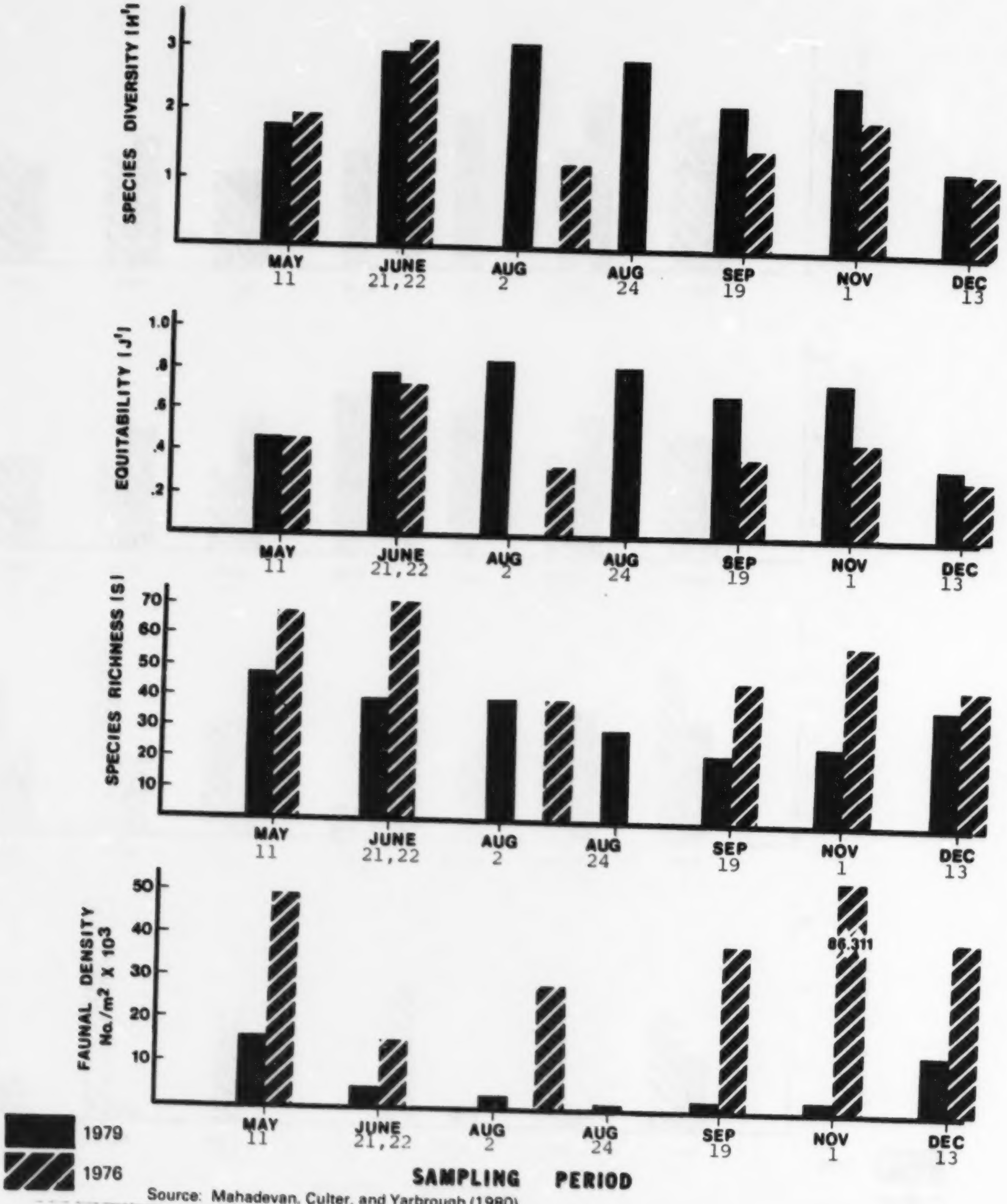
Figure 5-49. Comparison of the seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at Station 1 in the discharge canal of the Big Bend Powerplant during comparable sampling periods of 1976 and 1979.



Source: Mahadevan, Culter, and Yarbrough (1980).

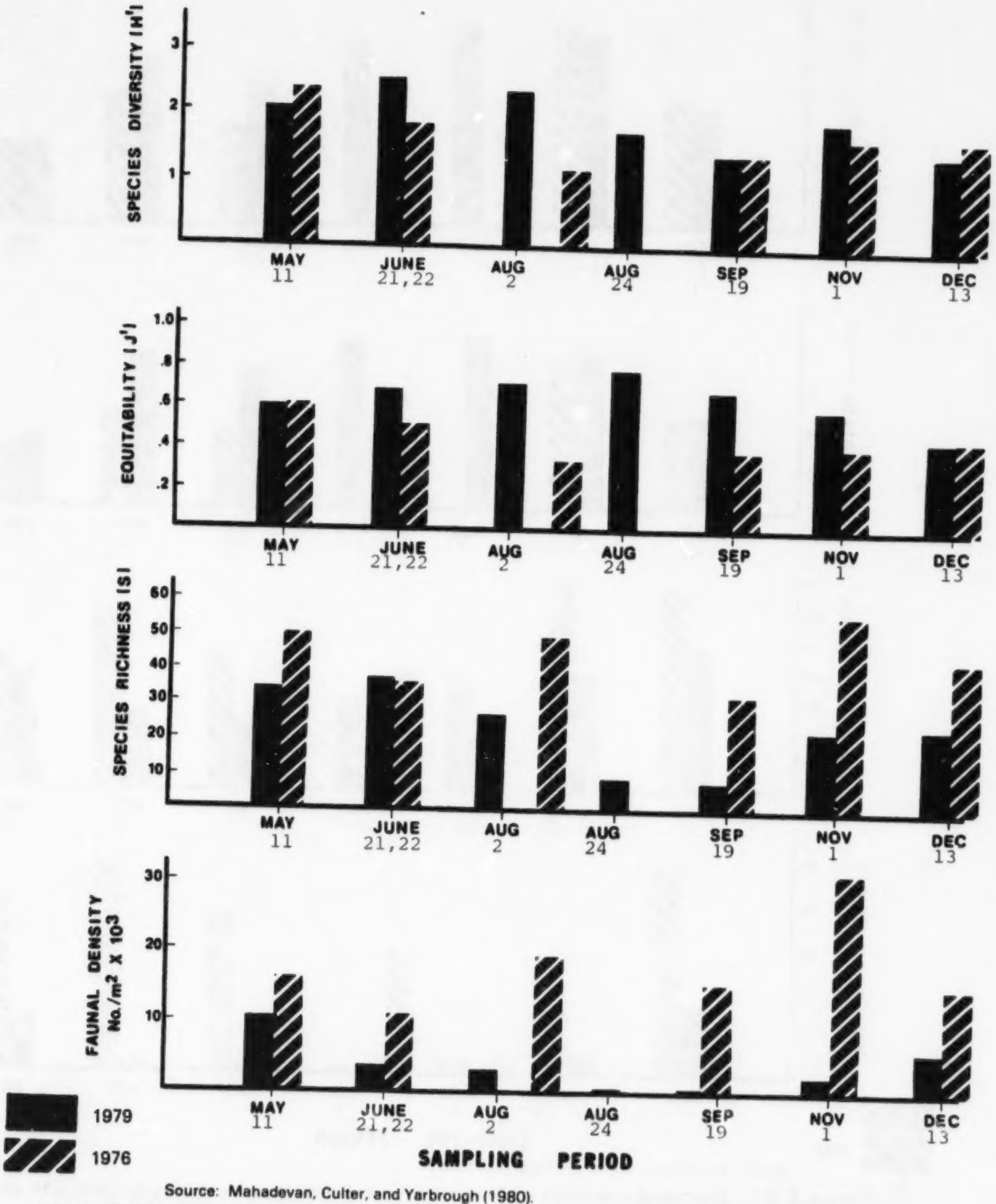
Figure 5-50. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at Station 2 in the discharge canal of the Big Bend Powerplant during comparable sampling periods of 1976 and 1979.

]



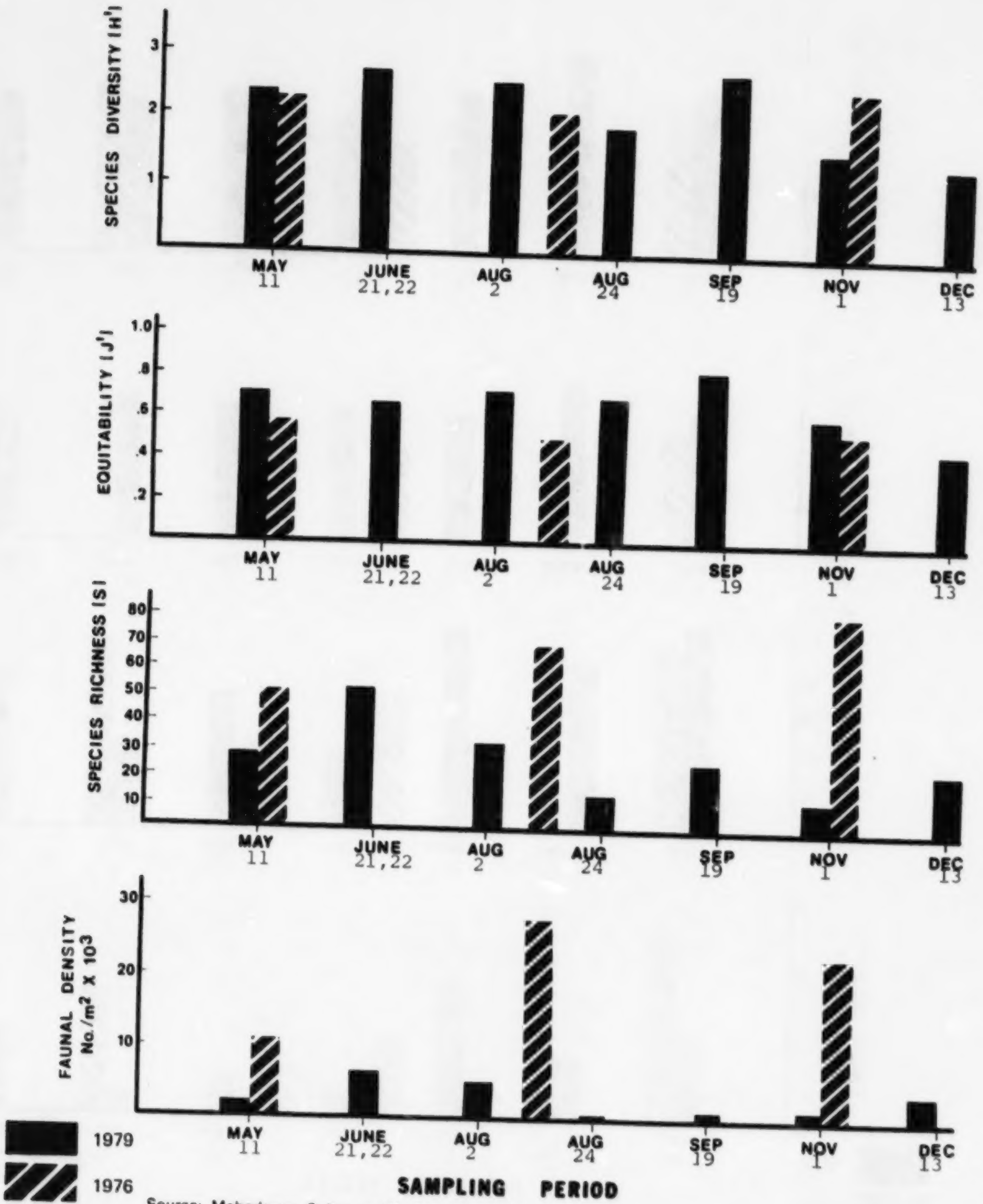
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-51. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal transect Station 4 near Big Bend during comparable sampling periods of 1976 and 1979.



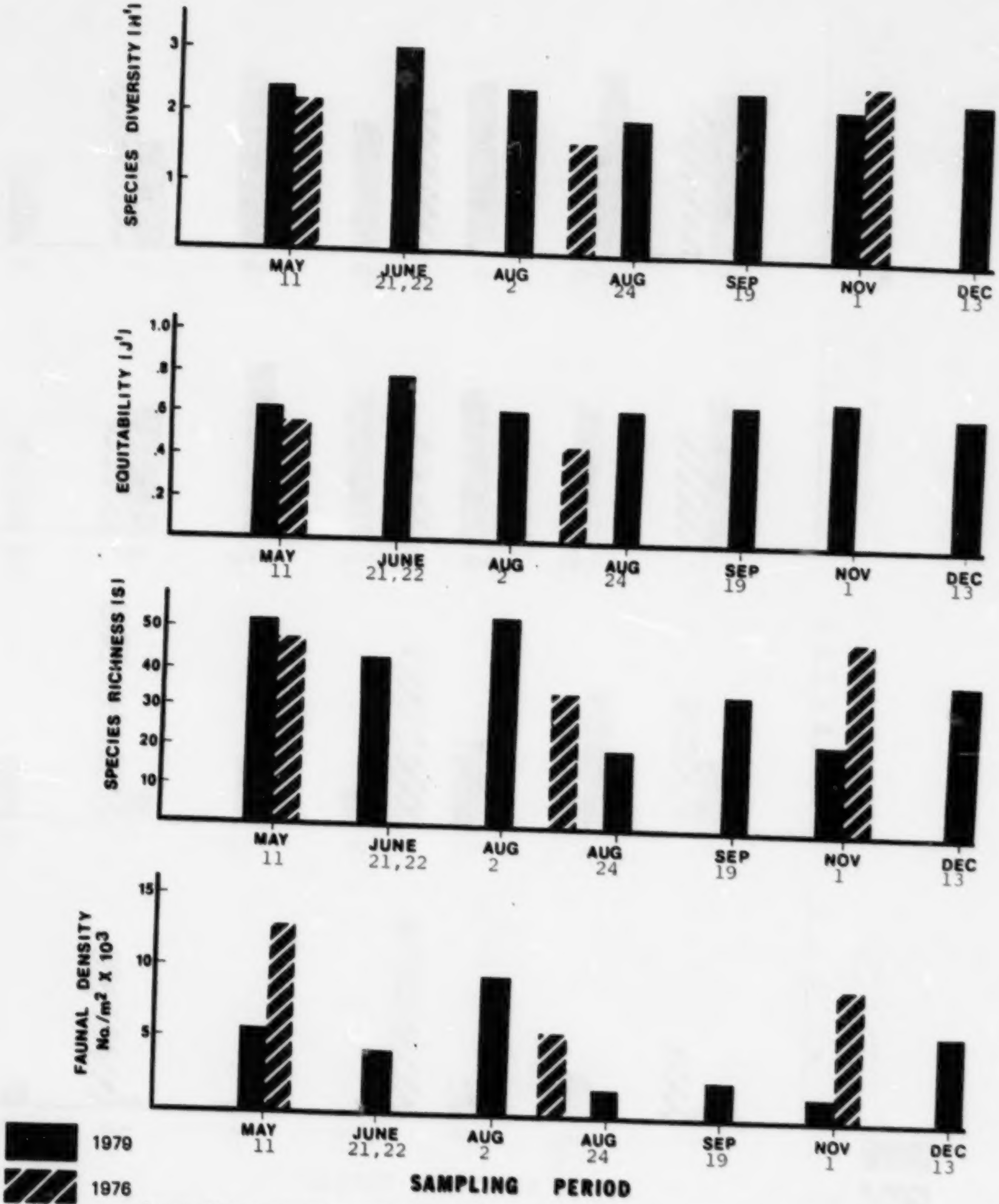
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-52. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal transect Station 5 near Big Bend during comparable sampling periods of 1976 and 1979.



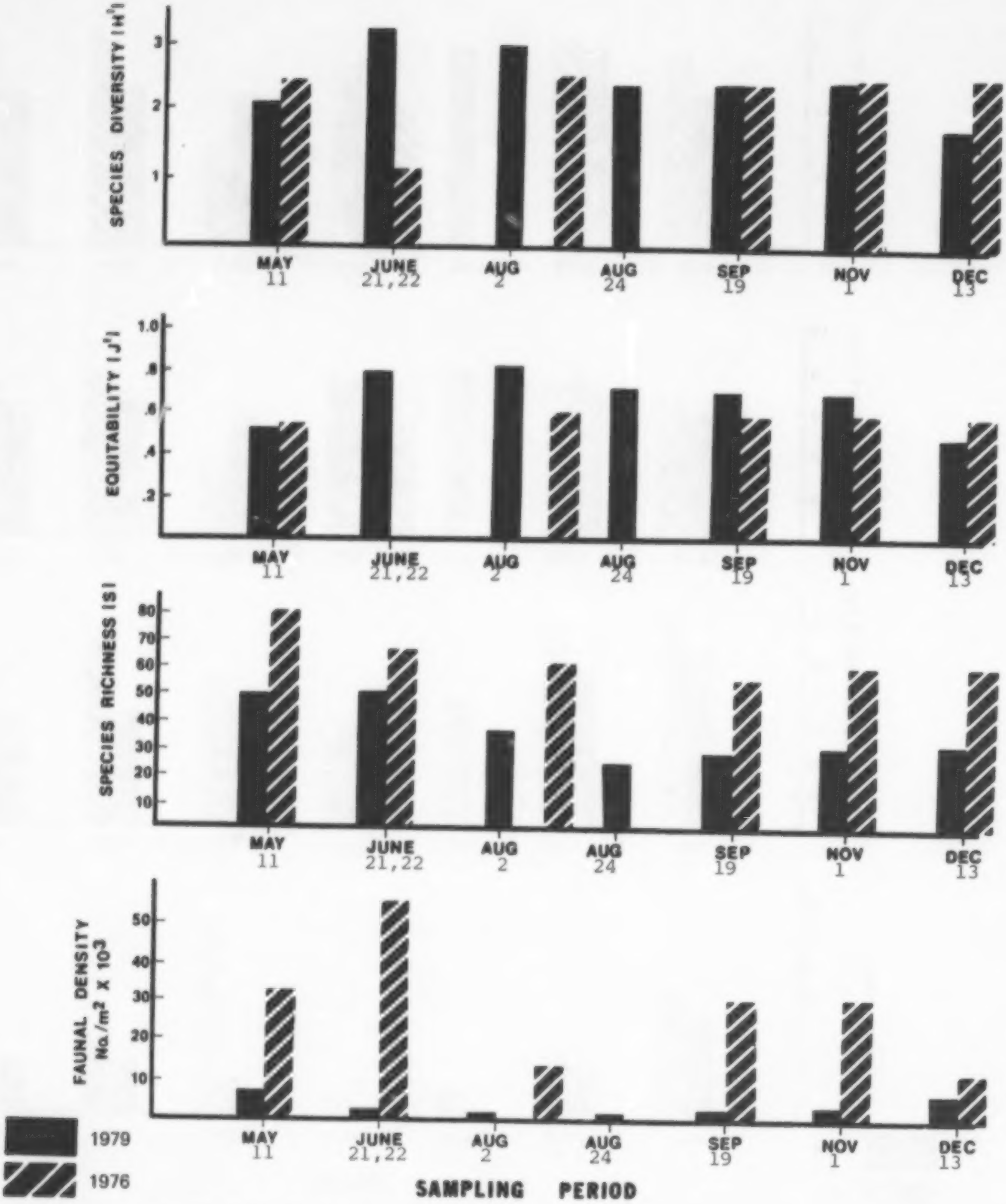
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-53. Seasonal variation of benthic invertebrate diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal transect Station 6 near Big Bend during comparable sampling periods of 1976 and 1979.



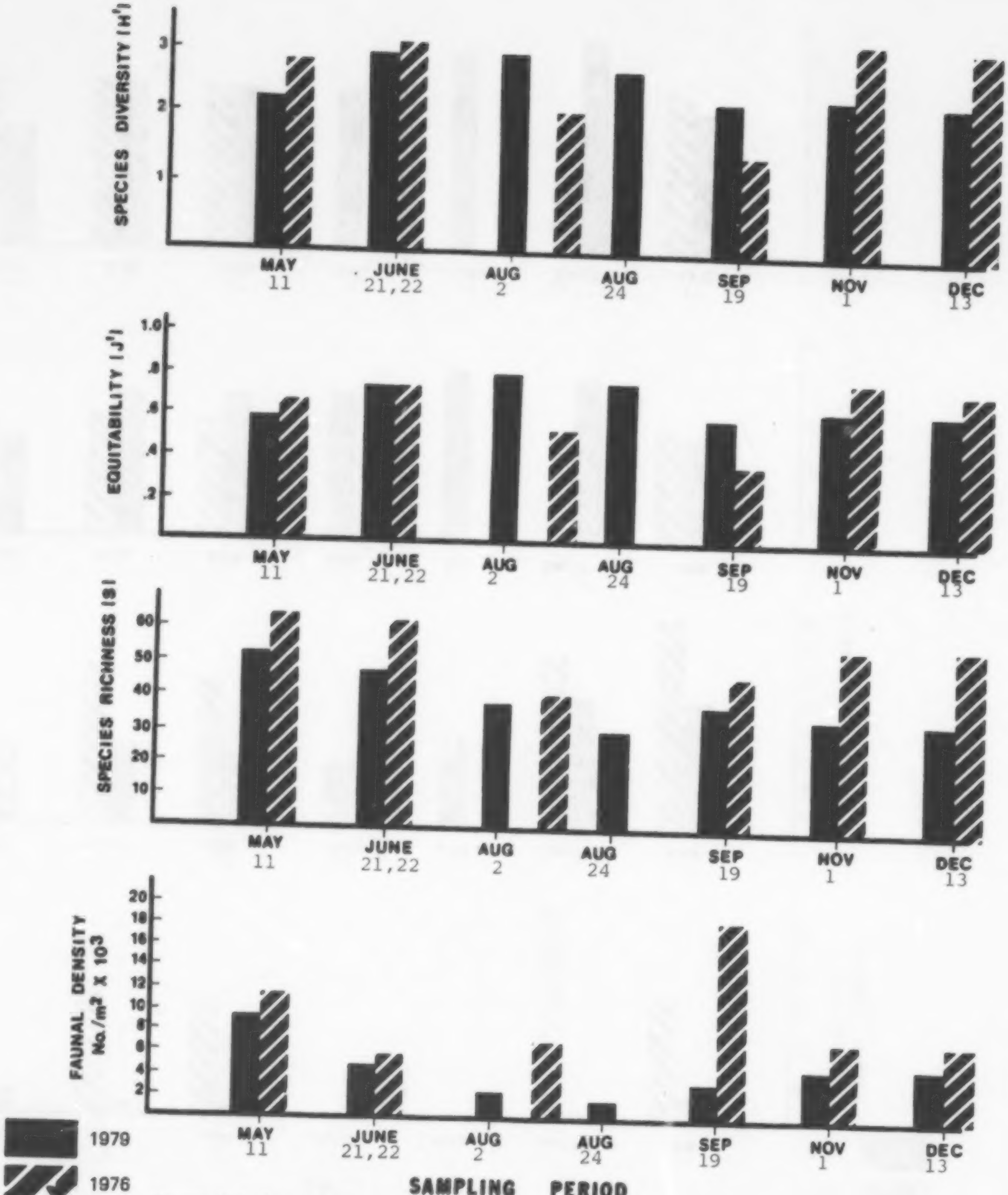
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-54. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at thermal transect Station 7 near Big Bend during comparable sampling periods of 1976 and 1979.



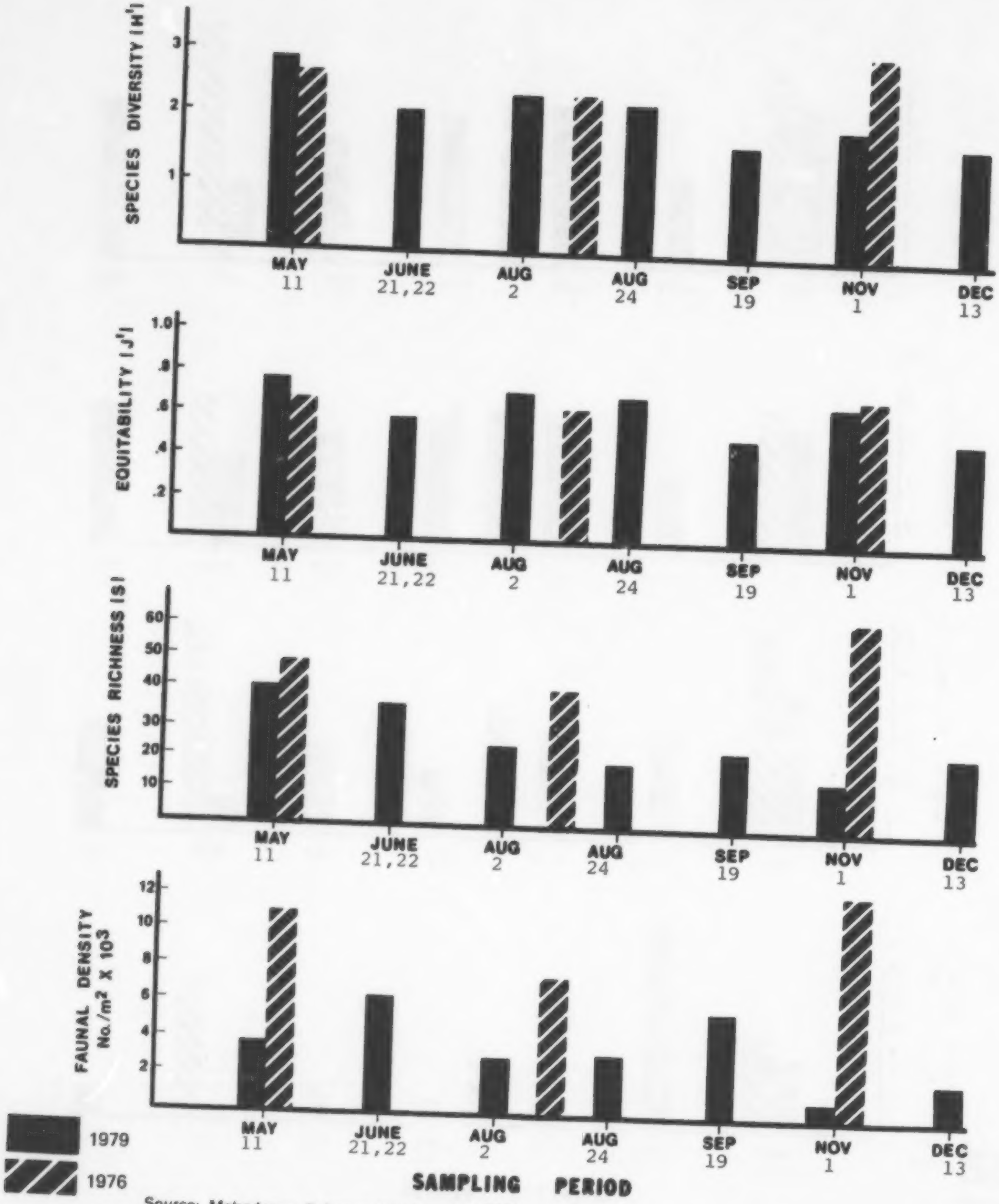
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-55. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at nonthermal transect Station 10 near Big Bend during comparable sampling periods of 1976 and 1979.



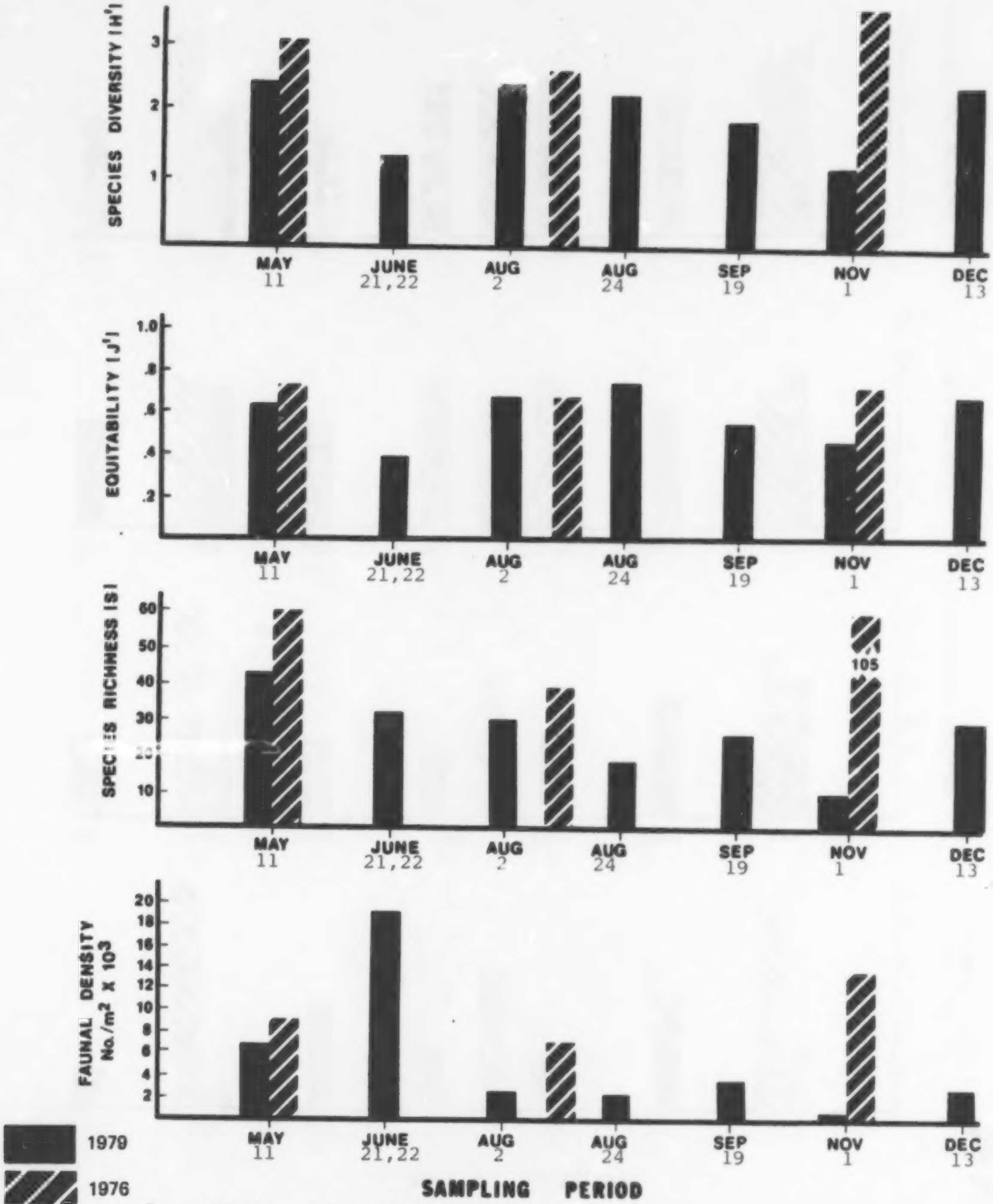
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-56. Seasonal variation of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at nonthermal transect Station 11 near Big Bend during comparable sampling periods of 1976 and 1979.



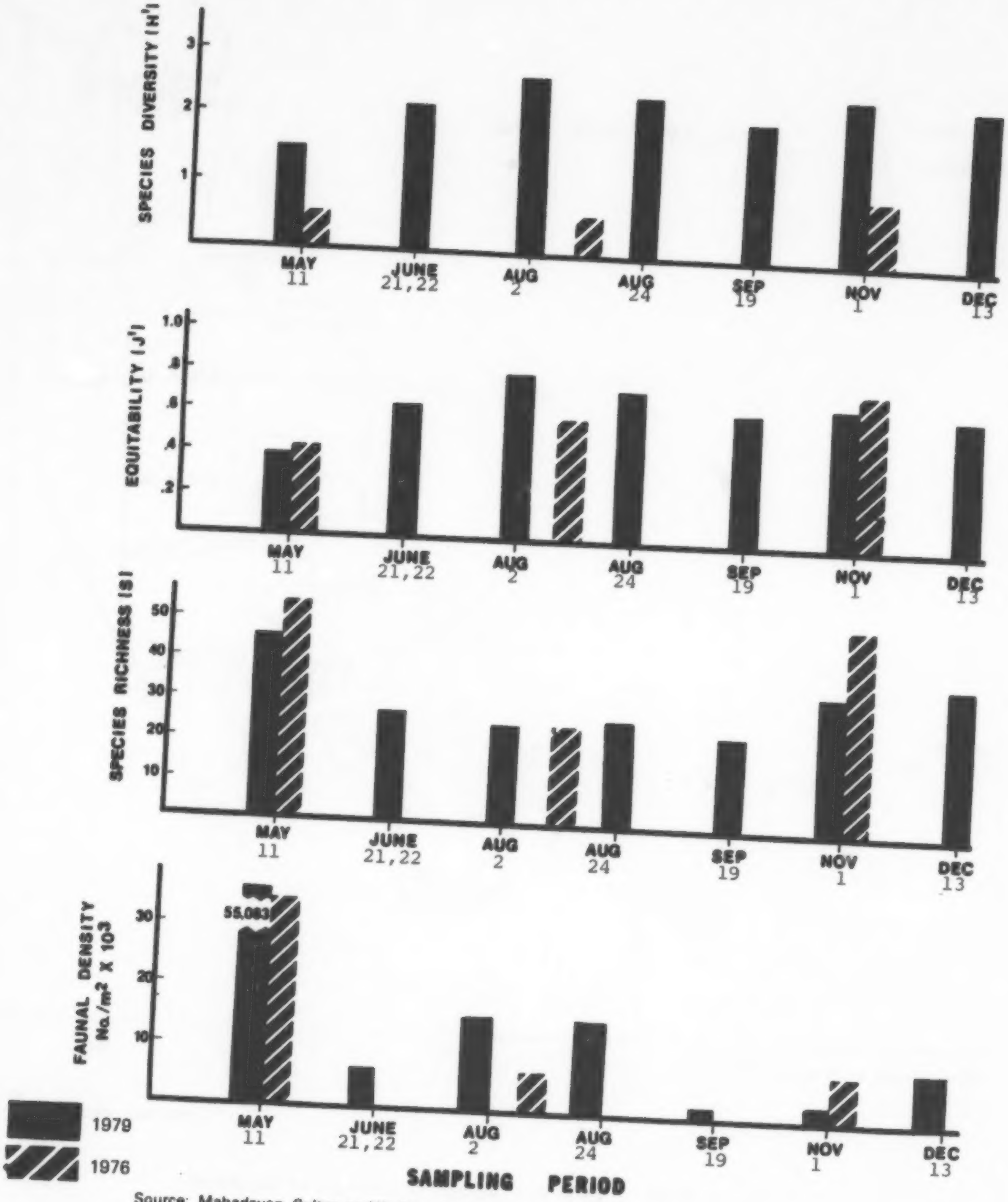
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-57. Seasonal distribution of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at nonthermal transect Station 12 near Big Bend during comparable sampling periods of 1976 and 1979.



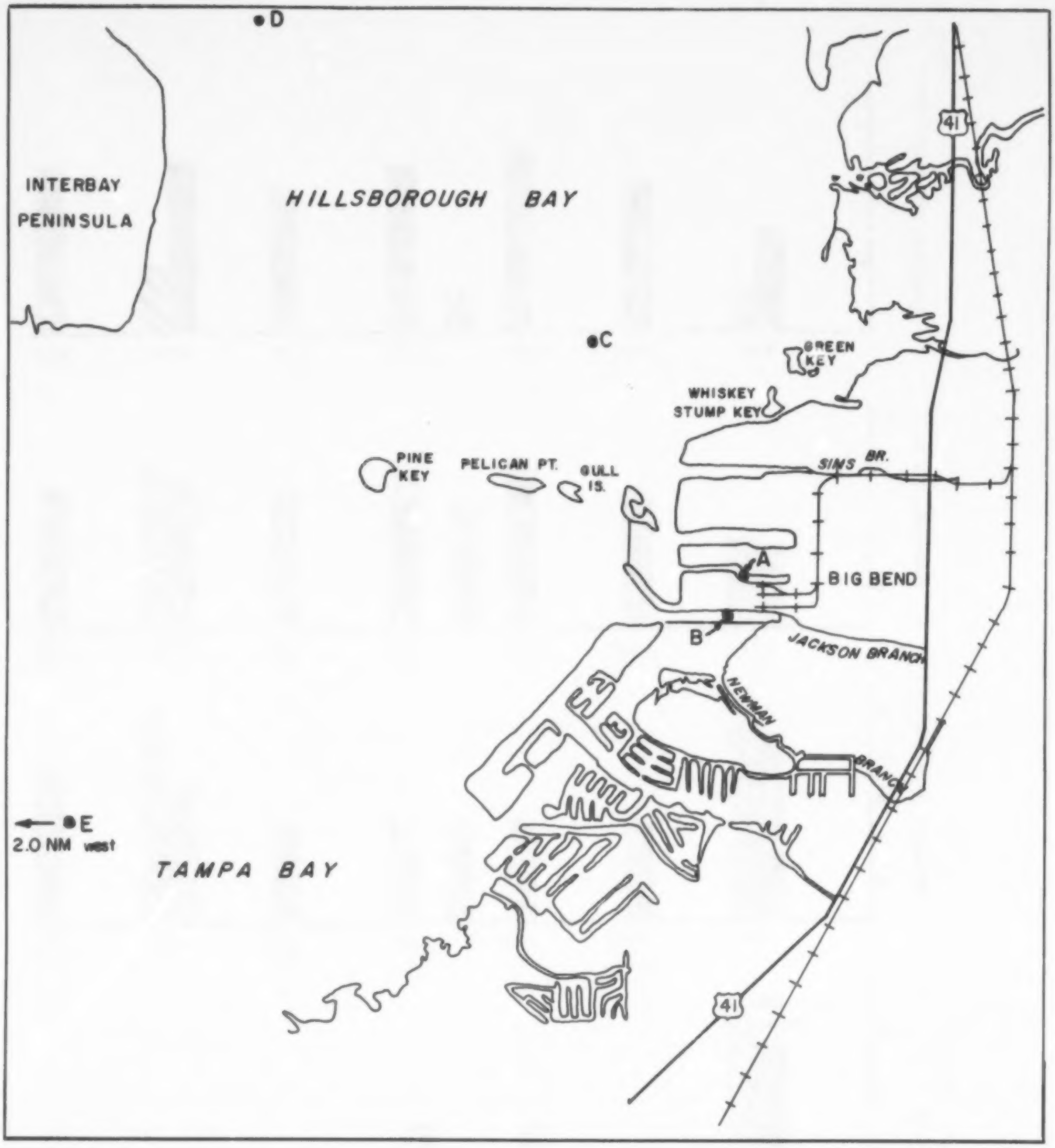
Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-58. Seasonal distribution of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at nonthermal transect Station 13 near Big Bend during comparable sampling periods of 1976 and 1979.



Source: Mahadevan, Culter, and Yarbrough (1980).

Figure 5-59. Seasonal distribution of benthic invertebrate species diversity (index H' of Shannon and Weaver 1963), equitability (index J' of Pielou 1966), species richness (number of species per station), and faunal density (total number of benthic invertebrates) at nonthermal transect Station 14 near Big Bend during comparable sampling periods of 1976 and 1979.


D
INTERBAY
PENINSULA
HILLSBOROUGH BAY
41
C
GREEN
KEY
WHISKEY
STUMP KEY
PINE
KEY
PELICAN PT.
GULL
IS.
SIMS BR.
A
BIG BEND
B
JACKSON BRANCH
NEWMAN
BRANCH
E
2.0 NM west
TAMPA BAY
41

Source: Phillips and Blanchet (1980a).

0
1
2 Miles

Figure 5-60. Oyster spat sampling stations at Big Bend, March 1979-January 1980.

5.4 DEMOGRAPHY

The proposed site for Big Bend 4 is the present Big Bend Station, which is on the eastern shore of Hillsborough Bay approximately 10 miles south of the City of Tampa and 5 miles north of Ruskin. The site and the entire area within 5 miles are all included in Hillsborough County.

In 1970, the population of Hillsborough County was 490,265, a 23.2 percent increase over its 1960 population of 397,788. The estimated population of Hillsborough County in January 1977 was 655,600, a 33.7 percent increase over the 1970 population and a 64.8 percent increase over the 1960 population (Hillsborough County Board of County Commissioners 1978). By 2020 the county population is projected to increase to over 1.1 million (University of Florida 1979), a 72 percent increase over 1977. Although over 45 percent of the total county population is contained within the City of Tampa, most recent growth has occurred in suburban and outlying areas. This trend is expected to continue.

Within a 5-mile radius of Big Bend Station are three census county divisions (CCD), Gibsonton, Ruskin, and Wimauma-Lithia, with estimated 1979 populations of 7,699, 19,184 and 14,277, respectively (Hillsborough County City-County Planning Commission 1979). These estimates represent increases of 73 percent, 125 percent, and 158 percent, respectively, over the 1970 populations of these CCDs (Hillsborough County City-County Planning Commission 1979; U.S. Department of Commerce 1971).

The population center nearest to the plant site is Apollo Beach, which is located just over 1 mile south of the site. It is a planned community that offers the amenities of a waterfront development. Ruskin, also located south of the site on the edge of the 5-mile radius, is the only other population center within 5 miles. Both Apollo Beach and Ruskin are classified as census designated places (CDP). According to the Department of Commerce, Bureau of the Census, a CDP (previously called an "unincorporated place") is defined as a community that has no legally defined limits and can be identified locally by place name (U.S. Department of Commerce 1977a). Population estimates of April 1, 1979, show Tract 141, which includes Apollo Beach and North Ruskin, to have a population of 10,395. The 1970 census for Tract 141 indicates a population of 5,050 (Hillsborough County City-County Planning Commission 1979). Figure 5-61 shows the locations of these towns with respect to the site. Table 5-109 summarizes recent population trends for CDPs and CCDs.

Several new residential subdivisions have been developed within 5 miles of the site since 1960. As shown in Figure 5-62, most of this development has occurred near the community of Gibsonton, north of the site, and along U.S. Highway 301 to the east. Figure 5-63 shows net population growth in Hillsborough County and in the site area between 1960 and 1970. Most population growth within 5 miles of the site has occurred near Gibsonton, while more limited growth has occurred in Apollo Beach and along U.S. Highways 41 and 301. Population growth and residential expansion in the site area can be expected to continue in and around these communities.

Population projections are available only for two of the three CCDs in the study area. These projections indicate that the Ruskin and Wimauma-Lithia divisions will undergo major population growth over the next 20 years. In Ruskin, this increase is estimated at over 415 percent, and in Wimauma-Lithia, which will remain more rural in character, the growth rate is still estimated to be over 115 percent (Hillsborough County Planning Commission 1977; Hillsborough County City-County Planning Commission 1979).

Table 5-109. Population of areas within 5 miles of the Big Bend site[a]

	1970	1979	1985	2000
County				
Hillsborough County	490,265	583,383[b]	--	910,900
County divisions				
Gibsonton	4,450	7,699[c]	--	--
Ruskin	8,510	19,184[c]	--	99,200[d]
Wimauma-Lithia	5,534	14,277[c]	--	30,700[d]
Places				
Apollo Beach	1,042	3,833	9,014	
Ruskin	2,414	7,094	10,401	

[a] From U.S. Department of Commerce (1971), University of Florida (1979), and Hillsborough County City-County Planning Commission (1979).

[b] Estimated population for 1978.

[c] Based on aggregated census tract data for equivalent area.

[d] Based on population projection for county planning sector equivalent to Census County Division.

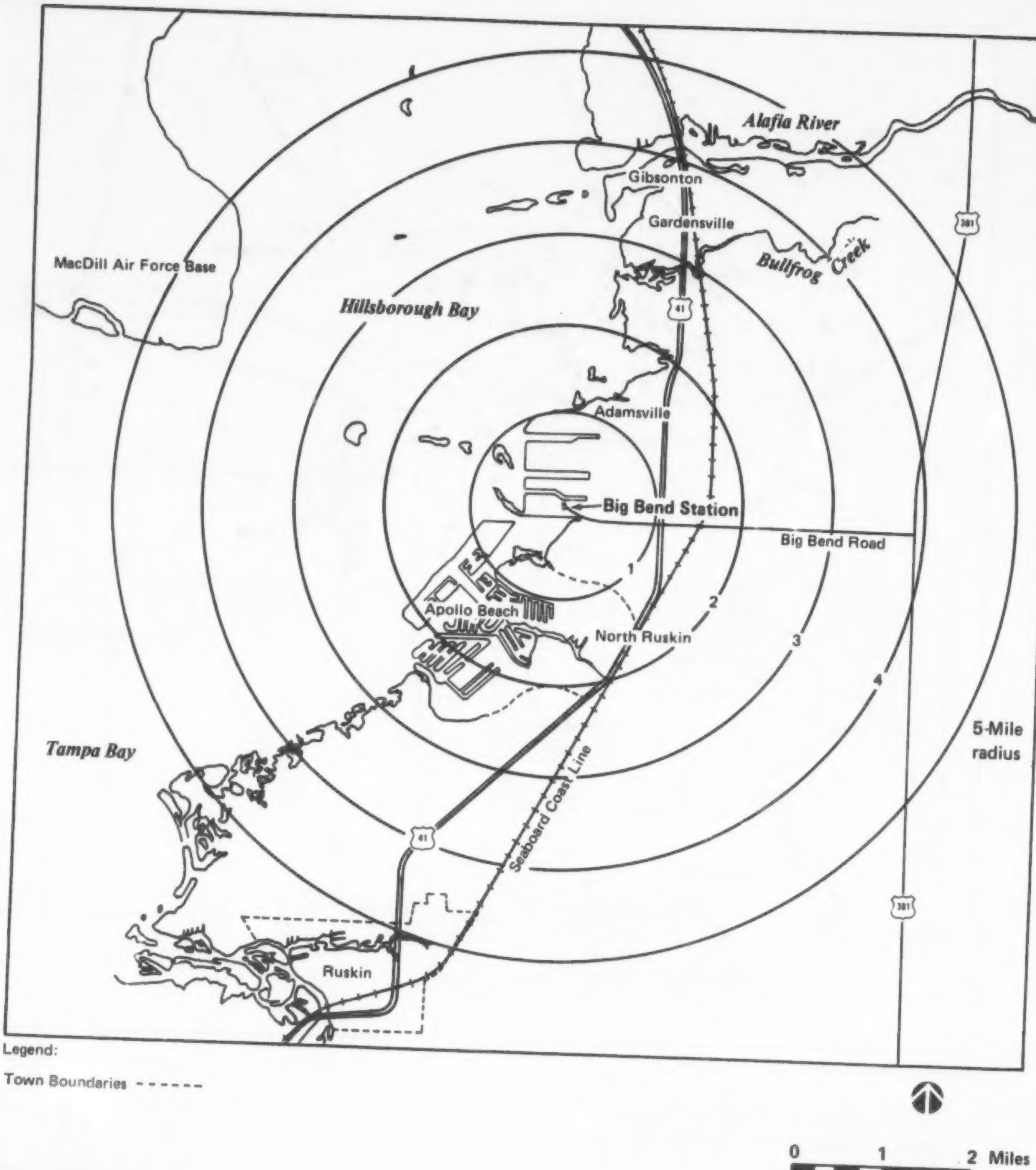
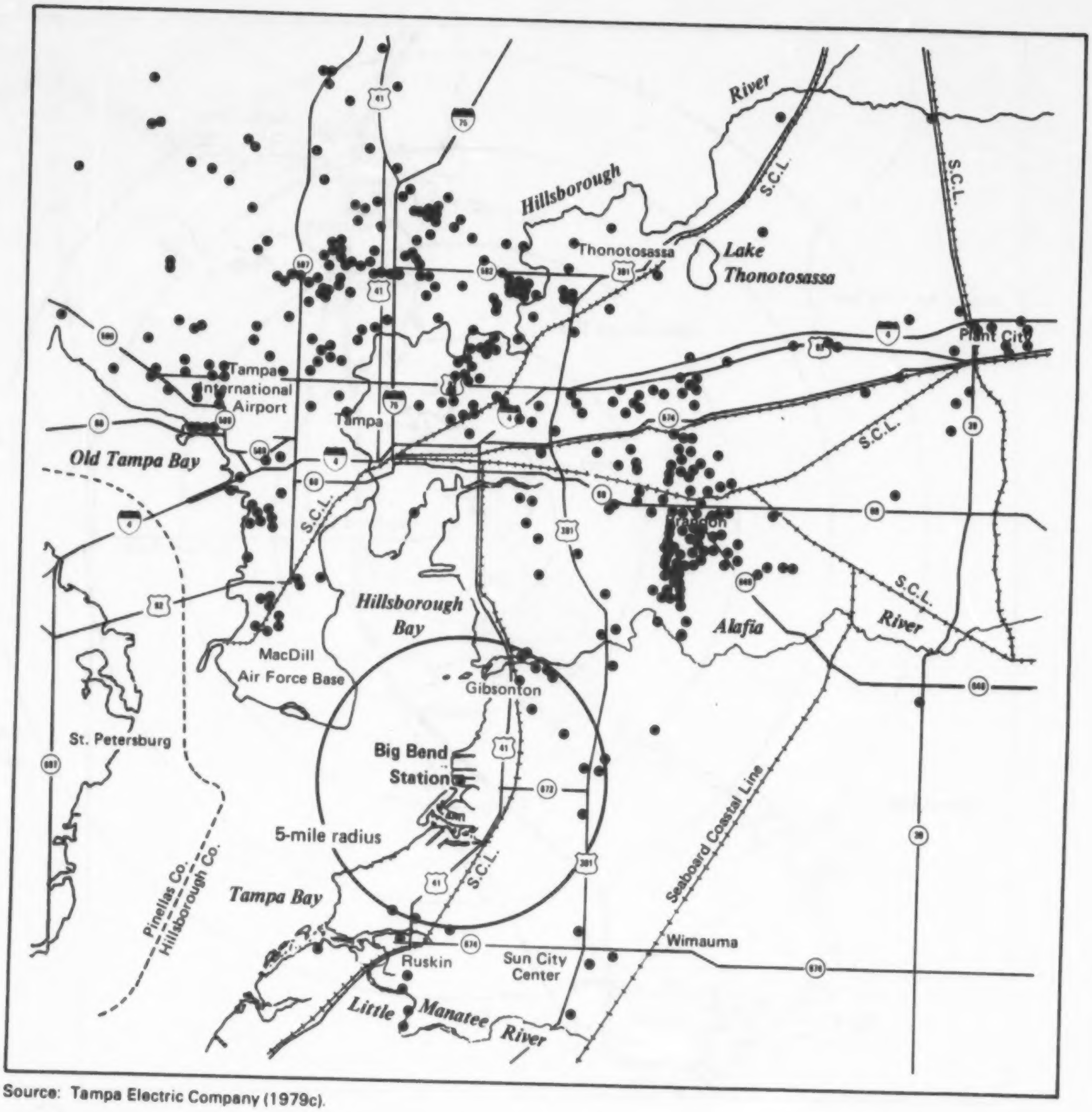

Alafia River
Gibsonton
Gardensville
Bullfrog Creek
301
MacDill Air Force Base
Hillsborough Bay
41
Adamsville
Big Bend Station
Big Bend Road
1
2
3
4
Apollo Beach
North Ruskin
5-Mile radius
Tampa Bay
Seaboard Coast Line
41
301
Ruskin
Legend:
Town Boundaries - - - - - -
0
1
2 Miles

Figure 5-61. Towns within a 5-mile radius of Big Bend Station.

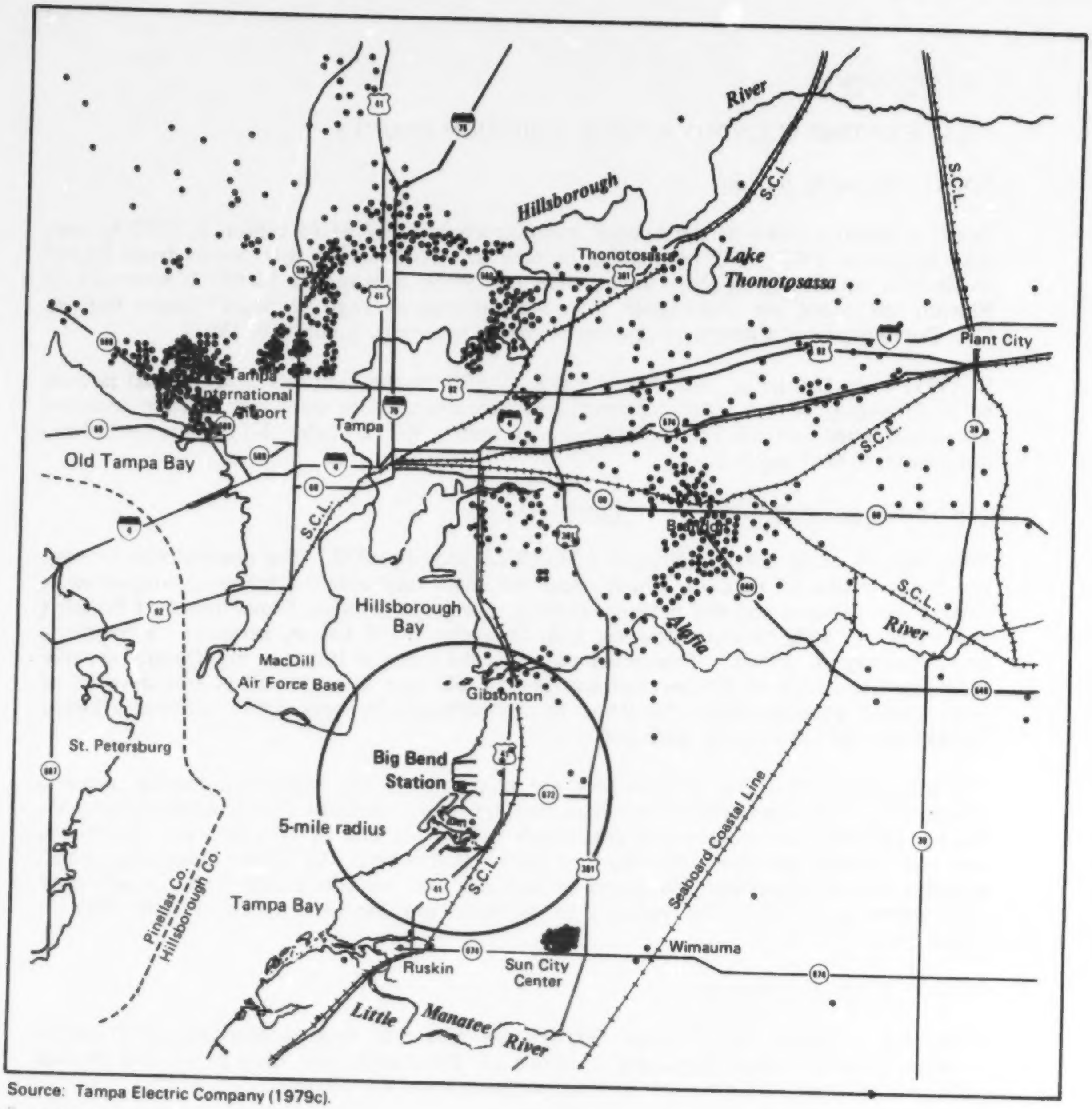

River
Hillsborough
S.C.L.
S.C.L.
Thonotosassa
Lake
Thonotosassa
Plant City
Tampa
International
Airport
Tampa
Old Tampa Bay
S.C.L.
S.C.L.
Brandon
Hillsborough
Bay
Alafia
River
S.C.L.
MacDill
Air Force Base
Gibsonton
St. Petersburg
Big Bend
Station
5-mile radius
Seaboard Coastal Line
Tampa Bay
Pinellas Co.
Hillsborough Co.
S.C.L.
Wimauma
Ruskin
Sun City
Center
Little Manatee River

Source: Tampa Electric Company (1979c).

- Each dot denotes the location of one new subdivision recorded between 1960 and 1970.

0 1 2 3 4 5 Miles

Figure 5-62. New subdivisions, 1960-1970, in the vicinity of Big Bend Station.


River
Hillsborough
S.C.L.
Thonotosassa
Lake Thonotosassa
Plant City
Tampa International Airport
Tampa
Old Tampa Bay
Hillsborough Bay
MacDill Air Force Base
Gibsonton
Big Bend Station
5-mile radius
St. Petersburg
Tampa Bay
Pinellas Co.
Hillsborough Co.
Ruskin
Sun City Center
Wimauma
Seaboard Coastal Line
Alafia
River
Little Manatee River
Brandon
0 1 2 3 4 5 Miles

Source: Tampa Electric Company (1979c).

- Each dot denotes a net increase of 100 persons between 1960 and 1970. The locations of the dots are approximation based on land development pattern.

Note:

Population growth pattern excludes the cities of Tampa and Plant City and MacDill AFB.

Figure 5-63. Net population growth pattern, 1960-1970, in the vicinity of Big Bend Station.

5.5 ECONOMY

5.5.1 EXISTING ECONOMY OF HILLSBOROUGH COUNTY

5.5.1.1 Personal Income

Total personal income in the county from approximately $1.69 billion in 1970 to over $3.5 billion in 1977. The per capita income also rose during this period from $3,416 to $6,145, which was slightly lower than the State average of $6,697 (University of Florida 1978) and yet was higher than the national average of $6,017 (Mary Barren, U.S. Department of Commerce, personal communication, January 9, 1980).

In 1977, manufacturing contributed $380,322,000 to the county's total annual payroll of $1.8 billion. Other major contributing business sectors were retail trade services and transportation (U.S. Department of Commerce 1979). Table 5-110 lists each business sector's 1977 payroll.

5.5.1.2 Employment and Labor Force

The county's labor force averaged 272,519 persons in 1978. The unemployment rate for the year was 5.5 percent, which compared favorably with the State's unemployment rate of 6.6 percent and the national rate of 6 percent (Florida Department of Banking and Finance 1978; Norman Bowers, U.S. Department of Labor, personal communication, January 9, 1980). This level of unemployment reflects a significant decline from the 1976 high of 9.9 percent and is probably due to a growth in employment of over 20,000 persons while the labor force increased by only 9,600 persons (Florida Department of Commerce, undated).

The majority of the county's workers are employed in the nonmanufacturing sectors, which consist of agricultural services and forestry; contract construction; transportation, utilities, and communication; trade (wholesale and retail); finance, insurance, and real estate; services; mining; and civil government. Of these industries, trade employs the most workers, followed by services and manufacturing (U.S. Department of Commerce 1979). The number of workers per business sector is indicated in Table 5-111.

5.5.1.3 Local Government

Plant City, Tampa, and Temple Terrace are the only incorporated places in Hillsborough County. The remaining portions of the county are unincorporated and as such receive their services and financial support from the county.

During the 1977-1978 fiscal year, total revenues accruing to the local governments within Hillsborough County amounted to $410,202,864. This figure includes the revenues of Plant City ($7,396,653), Temple Terrace ($9,456,878), Tampa ($161,824,626), the Hillsborough Industrial Special District ($57,747,618), and Hillsborough County itself ($173,777,089: Greater Tampa Chamber of Commerce, undated-a). Tables 5-112 and 5-113 show the sources of this revenue and each area's yearly expenditures.

5.5.1.4 Sales, Income Tax, and Bank Deposits

Taxes were the source of over 24 percent of the total revenue collected within the county during 1977-1978. Of the total revenue, 77 percent was raised from property taxes, 15 percent was from utility services taxes, and 8 percent was from franchise taxes (Florida Department of Banking and Finance 1978). Bank deposits in the county's 42 commercial banks in 1977 totaled slightly over $1.7 billion as compared to the state total of $27 billion. During the following year, bank deposits in the state increased by 12.2 percent, whereas the deposits made in Hillsborough County increased by 17.6 percent (Ms. Singer, Florida Department of Banking and Finance, personal communication, February 2, 1980).

5.5.1.5 Housing

Hillsborough County's total housing stock rose from 81,000 units in 1950 to approximately 234,000 units in 1976 (Hillsborough County Board of County Commissioners, 1978). Of the increase, 66 percent occurred between 1950 and 1960. Half of the increases occurred in the unincorporated areas of Hillsborough County as a result of the suburbanization of Tampa and Temple Terrace. From 1976 to 1978, 10,909 single-family units and 4,251 apartment units were added to the county's housing stock (Greater Tampa Chamber of Commerce, undated-b). Table 5-114 lists the total number of housing units in the county from 1950 to 1976. The price of a newly constructed home jumped from $42,759 in 1970 to $141,774 in 1978 (Greater Tampa Chamber of Commerce, undated-b). The three principal housing types in the county are conventional single-family units, multifamily units, and mobile homes. Between 1970 and 1976 the percentage of single-family homes decreased from 76 to 62.5 percent. Multifamily units, however, increased from 17.2 to 25.1 percent and mobile homes increased from 6.8 to 12.4 percent of the total housing stock (Hillsborough County Board of County Commissioners 1978). About 13,000 of the County's 1976-1977 total of 234,000 housing units were vacant. The majority of these vacancies were among the multifamily units. The average vacancy rate for all multifamily units was 11 percent. Of the occupied units, approximately two-thirds were owner occupied and the remaining third were renter occupied. This owner occupancy rate was 7 percent lower than the 1970 rate of 73 percent (Hillsborough County Board of County Commissioners 1978).

County officials estimated that 10 percent of the county's housing units during 1976-1977 were substandard. This figure was based solely upon exterior appearance, however, and interior inspections might have yielded a higher percentage. The county also considered 80 percent of the units suitable for rehabilitation since an economic savings could be realized by preserving as opposed to destroying and rebuilding such units (Hillsborough County Board of County Commissioners 1978).

5.5.2 FUTURE ECONOMY

Per capita income in the Tampa-St. Petersburg Standard Metropolitan Statistical Area (Hillsborough and Pinellas Counties) is projected to increase to $12,100 by the year 2020. This compares to a figure of $12,000 for the State of Florida and $13,200 for the entire United States (in terms of 1967 dollars). The rate of increase is greater than that projected for the United States but lower than that projected for the state (U.S. Water Resources Council 1974).

Employment is projected to increase by about 50 percent over the 1980-2020 period, reaching a total of 755,400 persons. During this same period population gains are forecast to outstrip the expansion in employment, growing over 77 percent by 2020. The consequent decrease in labor participation will result in an employed population/total population ratio for Tampa-St. Petersburg that is almost 30 percent below that for the United States (U.S. Water Resources Council 1974). Employment and income projections are summarized on Table 5-115.

Wholesale and retail trade contributed the greatest share to total earnings in 1980, although projections indicate that by 2020 the service sector will gain significantly, reaching 27 percent of total earnings, while trade will decline. Earnings from the government sector will climb to 16 percent by 2020 and the finance, insurance, and real estate sector will grow by 2 percent to become 9 percent of total earnings. While transportation will remain steady, all other employment sectors will decrease their share of total earnings (Table 5-116).

5.5.3 LOCAL COMMUNITY SERVICES

5.5.3.1 Electric Power, Water, and Wastewater Treatment

Electric power in Hillsborough County is provided by TECO. TECO serves over 296,000 persons and has at present a net generating capacity of 2,529 megawatts. During 1979 the peak summer demand was 1,861 megawatts and the average electrical use per residential customer was 12,792 kilowatts.

Hillsborough County has experienced significant population growth in recent years, and this has impaired the county's ability to provide water and wastewater services and to coordinate the delivery of other public services. The principal county wastewater treatment plant is located at Hookers Point. It has a design capacity of 60 millon gallons per day and discharges into Hillsborough Bay. The county also operates package plants for 22 public schools. Septic tanks provide individual sewage disposal and are currently used throughout much of the county, including Tampa, Temple Terrace, and Plant City (Hillsborough County Board of County Commissioners 1978). Table 2-24 shows the major sources of wastewater discharged into Hillsborough Bay.

The county water system has developed from the acquisition of privately owned water franchises and the development of the Riverview-Gibsonton system. The total system currently consists of 49 wells and 3 treatment plants located in Brandon, Riverview-Gibsonton, Ruskin, Sun City Center, and River Oaks. There are also two other small systems located in the northwest portion of the county. Together, these facilities provide the county with a pumping capacity of 29.9 mgd. The county plans to develop a new well field and treatment plant east of the Brandon system that will process an average daily demand of 49 mgd by the year 2000 (Hillsborough County Board of County Commissioners 1978). The Riverview-Gibsonton Water Plant and Well Field is located 4.75 miles northeast of the Big Bend site. This plant serves the communities of Riverview, Gibsonton, and Gardenville, as well as the Big Bend power station. The Apollo Beach well field, which is not part of the county system, serves the Apollo Beach community. This field is located northeast of the Big Bend site area along U.S. 301 (Tampa Electric Company 1979c). Table 5-117 provides information on the present and future water supply and demand in Hillsborough County.

5.5.3.2 Hospitals

Hillsborough County has 16 general specialty and military hospitals with a combined bed capacity of over 4,100. The county's medical staff includes more than 800 physicians and over 180 dentists. Tampa's medical facilities include a radiation clinic, cobalt treatment units, artificial kidney machines, cardiovascular units, a cerebral palsy clinic, and a mental health clinic. In addition, special emergency squads and a helicopter ambulance service are also available in Tampa (Greater Tampa Chamber of Commerce, undated-a). Fourteen of the county's licensed hospitals are located in Tampa—one is in Brandon, and the other is in Plant City. In 1978, these hospitals had a total of 677,318 patient days and an average occupancy rate of about 68 percent (Ms. Cynthia Raszkiewicz, Florida Gulf Health Systems Agency, personal communication, May 14, 1980). In 1977-1978, a total of over $53 million was spent for hospitals and ambulance and rescue services in Hillsborough County (Florida Department of Banking and Finance 1978).

5.5.3.3 Garbage Collection

Hillsborough County's garbage collection is provided by private franchised companies regulated by the county. Unincorporated areas are divided into five franchised areas. An area in the extreme northeast and another in the southeast, however, remain unfranchised. Residential waste is collected biweekly and industrial waste is collected more frequently as needed. At the time the county's Horizon 2000 Plan was formulated, waste disposal capacity was at best sufficient to last only until mid-1981. At that time there was an on going effort to site a major new landfill facility (Hillsborough County Board of County Commissioners 1978).

5.5.3.4 Schools

Hillsborough County's educational system consists of elementary, secondary, adult education, and college facilities. Over 41,500 adults attended county-supported credit and noncredit academic and vocational courses in 1978-1979 (Hillsborough County School Board 1979). Higher education is also available from the six colleges located in the county. These institutions are Florida College, Hillsborough Community College, Tampa College, Florida Beacon College, the University of Tampa, the University of South Florida, and the Tampa campus of the University of Florida. A number of vocational and trade schools are also located in the county (Lovejoy 1970).

The Hillsborough County School Board operates 126 schools, including 88 elementary schools, 1 middle school, 25 junior high schools, 11 senior high schools and 1 school for trainable, mentally handicapped students (Hillsborough County School Board 1979). Within 5 miles of the proposed site there are 3 schools: East Bay High School, Eisenhower Junior High, and Gibsonton Elementary. In 1977, these schools had enrollments of 2,695, 769, and 856 students, respectively (Tampa Electric Company 1979c). During the 1978-1979 school year, the school system had a total enrollment of 113,949 students and a teaching and administrative staff of 4,558. The county spent an average of $813.80 on each full-time student during the period; $2,479.58 on each exceptional student, and $1,348.09 on each vocational student. The revenue needed to run the Hillsborough County Schools comes from four sources (Hillsborough County School Board 1979). Table 5-118 lists the 1978-1979 sources and the expected 1979-1980 sources. The school system's current bonded indebtedness totals $2,564,846, which is attributable to bond issues in 1961, 1969, and 1978 (Hillsborough County School Board 1979).

Total enrollment has remained relatively stable over the past 5 years. During this period, enrollment in older neighborhoods has declined leaving underutilized facilities in these areas, while continuing suburban growth has resulted in growing enrollments and crowded schools in the developing section of the county. As a consequence, some schools in older areas have been closed and new schools have had to be built in suburban areas to accommodate new students. A new elementary school planned for the Apollo Beach area should have adequate capacity to serve this area and to accommodate additional growth (Paul Dennis, Hillsborough County School System, personal communication, May 13, 1980).

Table 5-110. Annual payroll of Hillsborough County by business sector[a]

Business sector	Payroll[b]
Agriculture	$ 10,043
Manufacturing	380,322
Transportation	226,486
Wholesale trade	249,384
Retail trade	285,895
Finance, insurance, real estate	141,869
Services	369,223
Contract construction	148,787
Mining	4,265
Nonclassifiable	3,775
Total	$ 1,820,004

[a] From U.S. Department of Commerce (1974).
[b] In thousands of dollars.

Table 5-111. Number of employees in Hillsborough County per business sector[a,b]

Business sector	Number of employees	Percentage of total
Agriculture	1,181	1
Manufacturing	32,213	17
Transportation	14,682	8
Wholesale trade	19,914	11
Retail trade	43,792	24
Finance, insurance, real estate	13,953	8
Services	44,538	24
Contract construction	13,258	7
Mining	361	1
Nonclassifiable	285	1
Total	184,177	100%

[a] From U.S. Department of Commerce (1979).
[b] Data excludes government employees.

Table 5-112. Hillsborough County area revenues, fiscal year ending September 30, 1978[a]

Revenues	Hillsborough County	Plant City	Tampa	Temple Terrace	Hillsborough Industrial Special District	Total county area
Taxes	$ 50,060,184	$1,757,295	$ 44,736,559	$1,349,550	$ 405,696	$ 98,309,284
Licenses and permits	1,803,167	121,012	3,221,239	75,823	27,700	5,248,941
Intergovernmental revenues	45,164,772	3,523,716	27,773,933	2,015,940	4,363,700	82,842,061
Charges for services	58,559,812	1,603,097	58,439,233	1,374,915	25,809,883	145,786,940
Fines and forfeitures	1,234,139	85,867	1,989,645	39,171	0	3,348,822
Miscellaneous revenues	8,658,665	305,666	5,336,818	1,030,638	8,714,684	24,046,471
Total revenues	165,480,739	7,396,653	141,497,427	5,886,037	39,321,663	359,582,579
Nonrevenue receipts	8,296,350	0	20,327,199	3,570,841	18,425,955	50,620,345
Total revenues and receipts	$173,777,089	$7,396,653	$161,824,626	$9,456,878	$57,747,618	$410,202,864

[a] From Florida Department of Banking and Finance (1978).

Table 5-113. Hillsborough County expenditures, fiscal year ending September 30, 1978[a]

Expenditure	Hillsborough County	Plant City	Tampa	Temple Terrace	Hillsborough Industrial Special District	Total county area
General government services	$ 30,543,634	$ 828,955	$ 10,695,435	$4,177,376	$ 0	$ 46,245,400
Public safety	30,025,059	1,159,366	34,777,096	1,466,094	0	67,427,615
Physical environment	22,411,254	3,818,825	169,501,505	1,938,227	0	197,669,811
Transportation	8,661,163	519,517	24,631,713	301,727	42,358,735	76,472,555
Economic environment	15,986,623	168,534	28,498,356	0	7,415,509	52,069,022
Human services	67,791,911	9,999	0	0	0	67,801,910
Cultural and recreation	8,524,903	592,262	11,259,544	1,647,017	2,676,344	24,700,070
Nonexpenditure disbursements	0	0	3,343,586	114	0	3,343,700
Total expenditures and disbursements	$183,944,547	$7,097,458	$282,707,235	$9,530,555	$52,450,288	$535,730,083

[a] From Florida Department of Banking and Finance (1978).

Table 5-114. Total housing units, Hillsborough County[a]

Area	1950	1960	1970	1976	1950-1976 (% change)
Tampa	40,614	94,936	100,852	111,299	174
Temple Terrace	110	1,068	2,258	3,848	3398
Plant City	2,954	5,240	5,332	6,052	105
County (Unincorp.)	37,694	34,162	60,113	112,752	199
Total	81,372	135,406	168,555	233,951	188

[a] From Hillsborough County Board of County Commissioners (1978).

Table 5-115. Summary of economic factors for the Tampa-St. Petersburg Standard Metropolitan Statistical Area, 1980-2020[a]

Factor	1980	1990	2000	2020	1980-2020 (% change)
Population	1,393,100	1,702,700	1,955,500	2,470,600	77
Per capita income (1967 dollars)	$ 4,300	$ 5,600	$ 7,400	$ 12,100	181
Total employment	501,400	587,600	669,700	755,400	50
Total personal income	$6,072,300	$9,625,400	$14,651,800	$30,140,800	396

[a] From U.S. Water Resources Council (1974).

Table 5-116. Earnings projections for the Tampa-St. Petersburg Standard Metropolitan Statistical Area, 1980-2020[a]

Business sector	1980	Percentage of total earnings (1980)	1990	2000	2020	Percentage of total earnings (2020)
Agriculture	$ 24,600	<1	$ 28,300	$ 33,500	$ 46,500	<1
Mining[b]	--	--	--	--	--	--
Construction	352,400	9	499,900	689,100	1,154,700	7
Manufacturing	605,400	15	880,100	1,226,500	2,118,300	13
Transportation, communications, and public utilities	312,800	8	479,400	701,900	1,308,400	8
Wholesale and retail trade	850,900	22	1,185,900	1,649,800	2,854,100	17
Finance, insurance, and real estate	290,700	7	484,500	760,400	1,563,100	9
Services	834,400	21	1,349,500	2,097,700	4,322,200	27
Government	572,100	14	883,600	1,316,300	2,562,300	16
Total	$3,844,300	97	$5,792,300	$8,476,500	$15,930,800	98

[a] From U.S. Water Resources Council (1974).
[b] Too small to project.

Table 5-117. Hillsborough County water supply and demand[a]

Location	1976 water supply and demand[b]						Projected year 2000 municipal demand		
	Capacity pumping/treatment		Storage capacity	Average daily demand	Peak day	GPCD[b]	Average daily demand[b]	Peak day[b]	Projected GPCD
Plant City	5.33	--	0.56	1.9	3.0	124	8.48	15.3	--
Tampa	100	96[c]	26.00	55.0	83.6	127	82.9	118.1	136
Temple Terrace	6.2	71[d]	0.50	1.45	2.6	120	3.4	7.5	--
Hillsborough County	29.9	71.1[e]	0.30	10.3	19.0	49.0	97.9	--	--
Brandon	12.1	--	0.00	3.9	7.4	142	--	--	--
Gibsonton/Riverview	3.5	3.5	1.00	2.4	3.7	138	--	--	--
Ruskin	1.8	1.2	0.20	0.3	0.5	72	--	--	--
Sun City Center	4.8	4.8	0.80	1.5	3.1	200	--	--	--
Total South/Central	22.2	4.7	2.00	8.1	14.7	--	--	--	--
Benjamin Road	3.0	--	0.25	0.9	1.6	--	--	--	--
Lakewood	1.1	--	0.10	0.3	0.6	--	--	--	--
River Oaks	2.5	2.4	0.60	0.8	1.7	150	--	--	--

Abbreviation: GPCD = gallons per capita per day.

[a] From Hillsborough County Board of County Commissioners (1978).
[b] In millions of gallons per day.
[c] Dry season treatment capacity, primarily spring water (Sulphur Springs and Crystal Springs).
[d] Wet season treatment capacity. Wet season raw water was highly colored and soft, thus requiring increased level of treatment.
[e] Not all water was treated before being consumed.

Table 5-118. Hillsborough County school system revenue sources[a]

Source	Revenue 1978-1979	Revenue 1979-1980
Federal	$ 15,781,327	$ 28,747,823
State	125,600,807	106,814,667
Local county	53,312,905	54,784,123
Fund balance	22,107,764	17,492,000
Total	$216,802,803	$207,838,613

[a] From Hillsborough County School Board (1979).

5.6 LAND USE

5.6.1 AGRICULTURAL LAND

Big Bend Station is located in a primarily rural area on the eastern shore of Hillsborough Bay. Within 5 miles of this site the land is primarily agricultural or undeveloped (see Figure 5-61). The principal crops in the region are commercial vegetables, tomatoes, and strawberries. South of Ruskin, tomatoes and strawberries are grown extensively. Overall, the site area's soil characteristics do not favor field crops such as corn and grain. With irrigation and fertilization, however, fruit and vegetables can be grown. Despite this, citrus growing is not prevalent within 5 miles of the site. Livestock raising and dairy farming are two other agricultural activities occurring within the Big Bend Station area. Overall, much of the area's agricultural land is used for pasture (Tampa Electric Company 1979c). Table 5-119 lists the county's vegetable crop acreage between 1975 and 1978.

Although the county's total farm acreage decreased by 4 percent between 1969 and 1974, the production of certain agricultural products such as sheep and vegetables increased (U.S. Department of Commerce 1977b). Table 5-120 shows the changes in the county's agricultural statistics between 1969 and 1974 (Florida Crop and Livestock Reporting Service, 1979a,b,c).

5.6.2 RESIDENTIAL LAND

Swamps, flood-prone areas, and ecologically sensitive coastal waters limit development of the area immediately adjacent to the site. Currently, the largest residential areas within 5 miles of the site area are Gibsonton, Gardenville, and Apollo Beach. In addition to these communities, the towns of Adamsville and North Ruskin are within a 5-mile radius. The remaining lands within the radius are agricultural lands, open space/recreational land, or unzoned areas (Tampa Electric Company 1979c).

5.6.3 INDUSTRIAL AND COMMERCIAL LAND

The only industrial site within 5 miles of the Big Bend site is a phosphate-mining plant located to the north along U.S. 41. There are few commercial centers within the radius, although some commercial establishments are scattered along U.S. 41 (Tampa Electric Company 1979c). Figure 5-64 shows land uses within 5 miles of the site.

5.6.4 RECREATIONAL LAND

Six parks and three recreational areas are located in or near the area within a 5-mile radius of the site. Of these, Island Park is being developed and three of the existing parks are undergoing expansion. Four of the parks are located north of Gibsonton along the Alafia River, one is located east of Big Bend Station, and one is on the edge of Tampa Bay just over 5 miles southwest of the site. Hillsborough County established these parks for the protection of animal and plant life as well as for recreational purposes (Tampa Electric Company 1979c). Table 5-121 lists the parks and recreational areas and their facilities. One of the recreation areas, Apollo Beach, was established for the use of the residents of the Apollo Beach community (Tampa Electric Company 1979). The locations of all the recreational lands are indicated in Figure 5-65.

5.6.5 HISTORIC AND ARCHAEOLOGICAL SITES

It has been determined that no sites presently listed in the National Register of Historic Places and the Registry of Natural Landmarks occur within a 5-mile radius of the Big Bend site (Tampa Electric Company 1979c).

The Florida Department of State, Division of Archives, History, and Records Management, lists 28 archaeological sites within 5 miles of Big Bend Station. These sites are listed in Table 5-122 and their location is shown in Figure 5-66. The majority of these sites are sand mounds or shell mounds and three are burial mounds (Tampa Electric Company 1979c). The Bureau of Historic Sites and Properties has requested that the exact location of these sites remain confidential in order to protect them from scavengers and curiosity seekers (George W. Percy, Florida Department of State, Bureau of Historic Sites and Properties, personal communication, February 22, 1980). There are no recorded State historic sites within the site area.

In response to a request by TECO, a cultural assessment of the area proposed for Big Bend Unit 4 and its associated facilities was conducted in 1979. A review of the Florida Master Site File revealed no archaeological or historic sites or properties located within the tracts under investigation. Assessment data also led to the conclusion that the proposed development would most likely not affect any sites listed, or eligible for listing, on the National Register of Historic Places (Tampa Electric Company 1979c).

5.6.6 FUTURE LAND USE

Development of the land within 5 miles of the site is limited because of the existence of swamps and flood-prone areas. The growth that is anticipated is projected to occur along the shoreline, along major highways, and around Gibsonton and Ruskin. In addition, the area around Apollo Beach will continue to grow. The Horizon 2000 Plan calls for residential development at a density of between 2.6 and 7.5 dwelling units per acre in the area just south of Big Bend Road and west of U.S. 41. Much of the region south of Big Bend Road and east of U.S. 41 is projected to remain rural. (Hillsborough County Board of County Commissioners 1978). The Horizon 2000 Plan for Hillsborough County is shown in Figure 5-67. The plan calls for Big Bend Station to be a heavy industrial area in the year 2000, and the installation of power-generating facilities would be consistent with such a land-use projection (Tampa Electric Company 1979c).

Currently, TECO owns or has purchase agreements on approximately 1,675 acres of land. The land that is situated south of Big Bend Road and is under purchase agreement consists of approximately 86 acres. This land was zoned "A", and its intended use was determined by the Hillsborough County Zoning Administrator to be consistent with A zoning. Recently, TECO's request has been granted for a rezoning of this land from a category of A to "M-1," which is an industrial category consistent with the existing generating station. With the exception of a small area (approximately 40 acres) north of Big Bend Road, the area immediately south and southwest of the plant that is zoned A, and three small parcels of land that are zoned R1MH, all other property owned by TECO is zoned M-1 (Tampa Electric Company, 1980c).

Table 5-119. Hillsborough County selected vegetable crops, 1975-1978[a]

Crop	Acreage 1975-1976	1976-1977	1977-1978
Snap beans	850	950	1250
Cabbage	520	250	300
Cucumbers	100	200	220
Green peppers	350	800	870
Squash	900	800	900
Strawberries	900	1100	1800
Tomatoes	4345	4945	5530
Watermelons	350	1[b]	1[b]

[a] From Florida Crop and Livestock Reporting Service (March 1979a).
[b] A very small amount.

Table 5-120. Hillsborough County agricultural statistics, 1969 and 1974[a]

Category	1969	1974	Change (%)
Number of farms	2,769	2,335	-15.7
Total acreage in farms	374,767	358,178	-4.4
Average farm size (acres)	135	153	+13.3
Proportion of total acreage in farms (%)	56	54	-3.5
Average value per farm	$73,190	$180,822	+147
Market value of agricultural products sold	$58,532,000	$108,530,000	+85.4
Total cropland (acres)	117,712	110,945	-5.8
Total harvested cropland (acres)	68,204	58,274	-14.6
Cropland used for grazing (acres)	39,614	46,511	-17.4
Total woodland (acres)	101,777	63,672	-37.4
Cattle and calves	81,320	95,907	+17.9
Hogs	6,539	4,541	-30.6
Sheep and lambs	221	298	+34.8
Broilers and meat chickens	9,209	82	-99.1
Hens of laying age	1,949,019	2,894,724	+48.5
Hay crops (acres)	6,586	6,451	-2.1
Corn (acres)	799	280	-65.0
Vegetable crops, sweet corn, or melons (acres)	5,635	6,758	+19.9
Berries (acres)	607	529	-12.9

[a] From U.S. Department of Commerce (1977b).

Table 5-121. Parks and recreation areas near Big Bend[a]

Parks	Facilities and activities
Bullfrog Creek Park	Athletic fields, fishing, nature trails, picnicking, playground
Williams Park	Boat ramp, fishing, picnicking
I. G. Simmons Park	Boat ramp, camping, fishing, nature trails, picnicking, playground, swimming, bathhouse
J. B. Gibson	Athletic field, playground, civic building, picnicking
Gardinier	Fishing, picnicking, tennis courts
Gardenville	Athletic fields, community center, playground, shuffleboard, volleyball, basketball
Apollo Beach	--

[a] From Tampa Electric Company (1979c).

Table 5-122. Archaeological sites within 5 miles of the Big Bend site[a]

Type of site	Number
Sand mound	9
Shell midden	3
Shell mound	4
Flint and sherd area	1
Human bone and sherd area, surface	1
Shell-capped sand mound	2
Burial mound	3
Sand ridge	1
Sandpit	1
Cemetery	1
Dredged beach, transitional period	1
Shell mound, destroyed	1
Total	28

[a] From Tampa Electric Company (1979c).

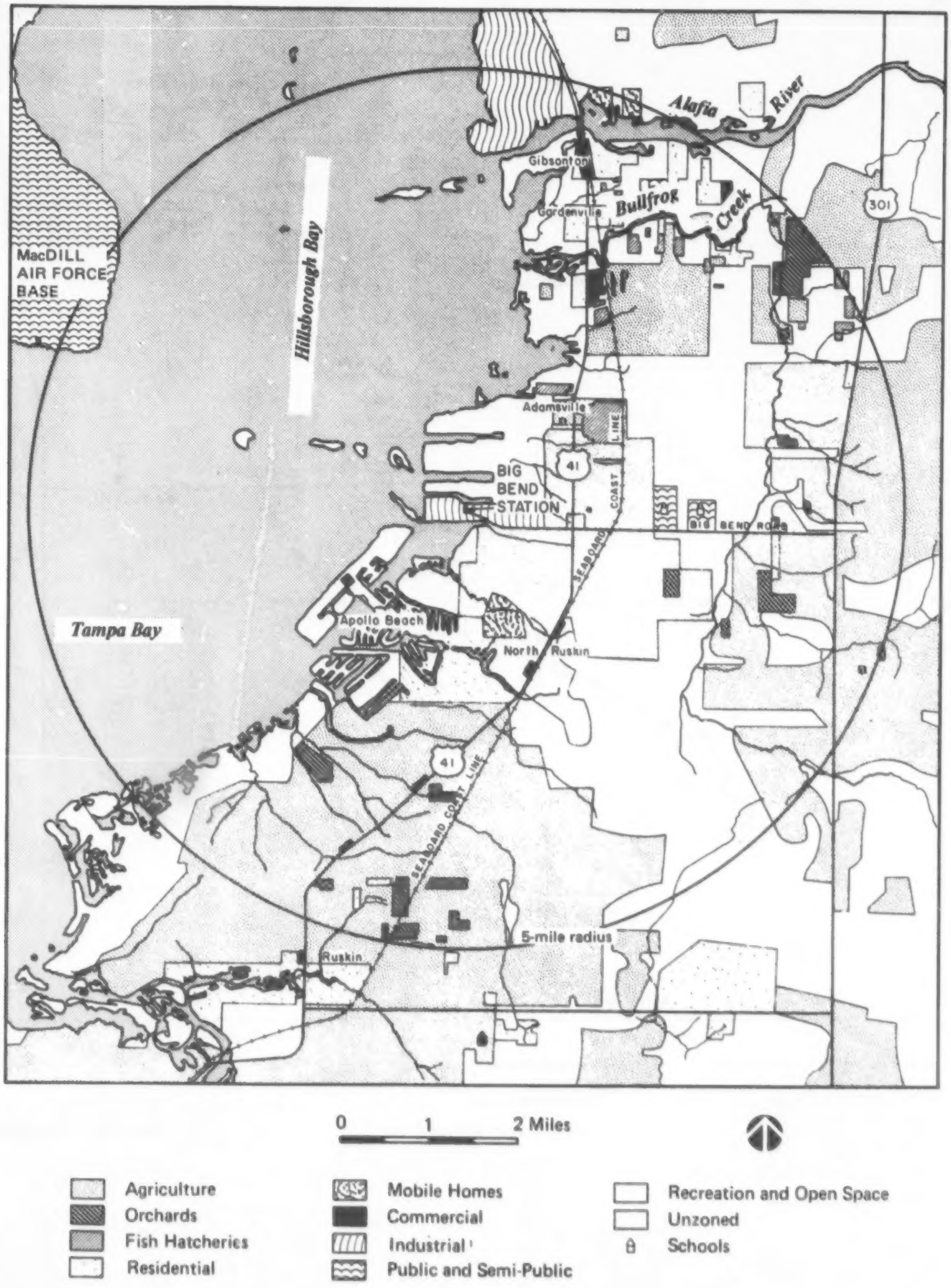

Alafia River
Gibsonton
Gordonville
Bullfrog Creek
301
MacDILL AIR FORCE BASE
Hillsborough Bay
Adamsville
41
SEABOARD COAST LINE
BIG BEND STATION
BIG BEND ROAD
Apollo Beach
North Ruskin
Tampa Bay
5-mile radius
Ruskin
0 1 2 Miles
Agriculture
Orchards
Fish Hatcheries
Residential
Mobile Homes
Commercial
Industrial
Public and Semi-Public
Recreation and Open Space
Unzoned
Schools

Figure 5-64. Existing land use in the vicinity of Big Bend Station.

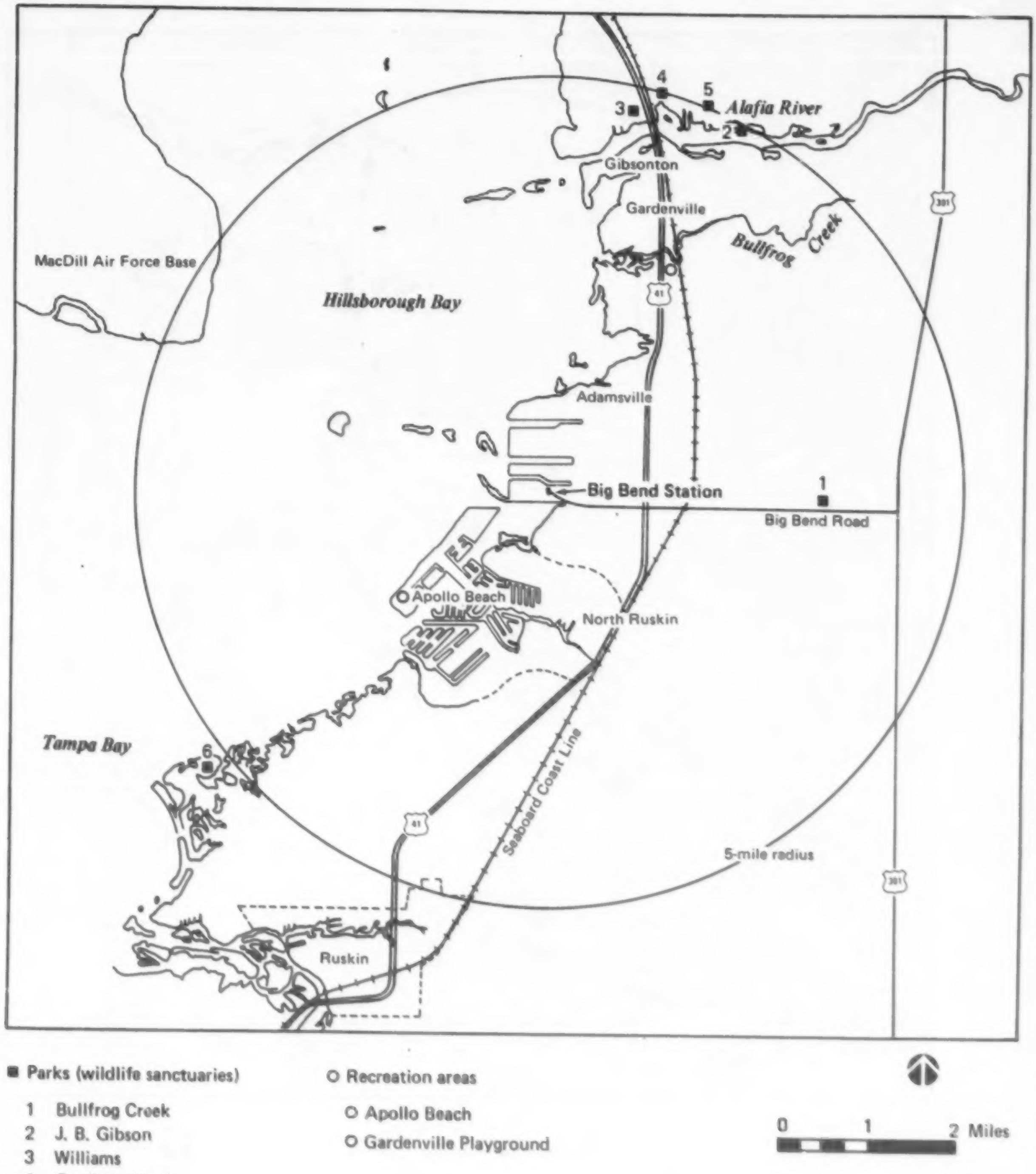

4
5
3
Alafia River
2
Gibsonton
Gardenville
Bullfrog Creek
301
MacDill Air Force Base
Hillsborough Bay
41
Adamsville
Big Bend Station
1
Big Bend Road
Apollo Beach
North Ruskin
Tampa Bay
6
Seaboard Coast Line
41
5-mile radius
301
Ruskin
■ Parks (wildlife sanctuaries)
1 Bullfrog Creek
2 J. B. Gibson
3 Williams
4 Gardinier Alafia
5 E. G. Simmons
○ Recreation areas
○ Apollo Beach
○ Gardenville Playground
0
1
2 Miles

Figure 5-65. Park, beach, wildlife, and conservation areas in the vicinity of Big Bend Station.

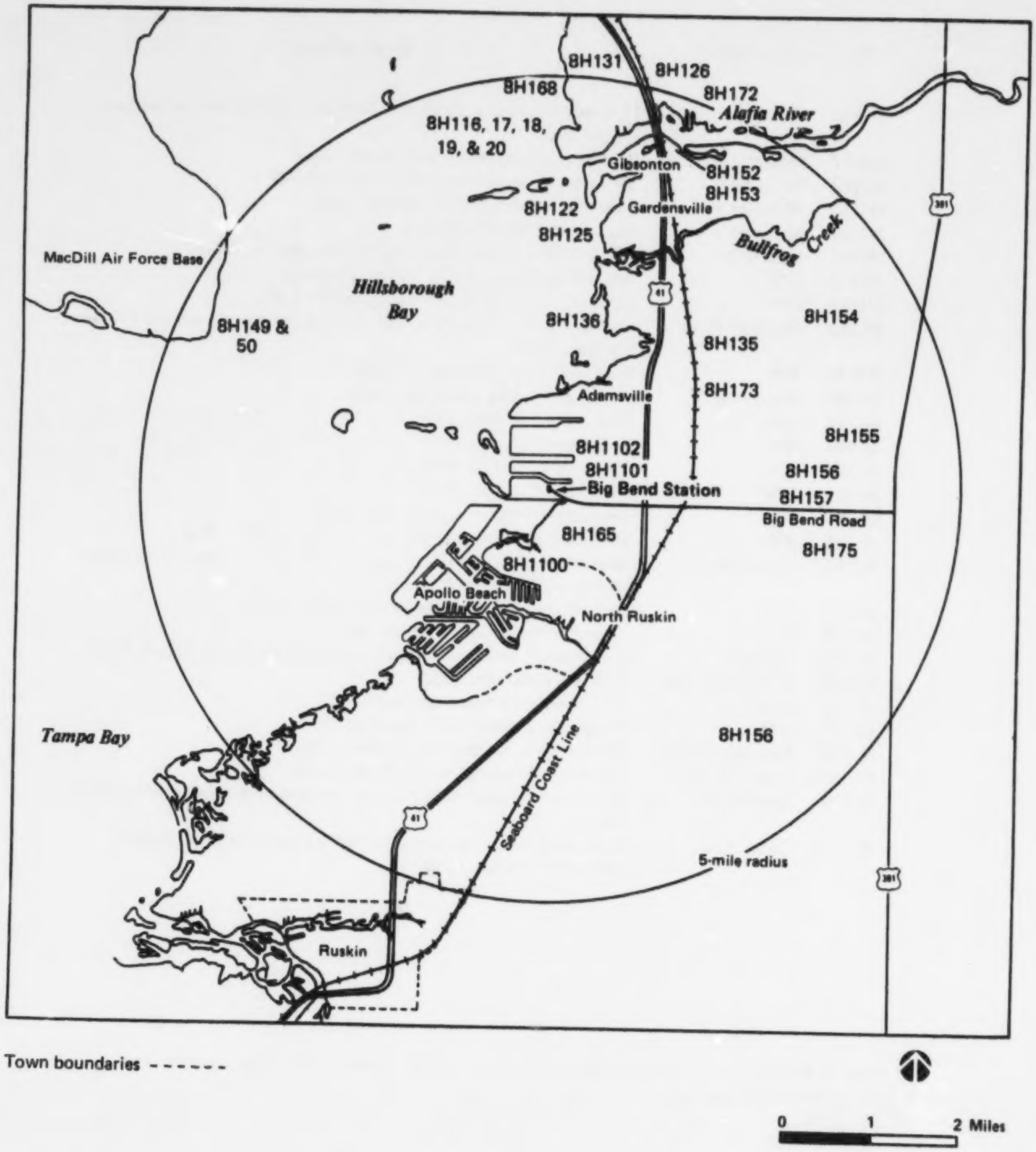
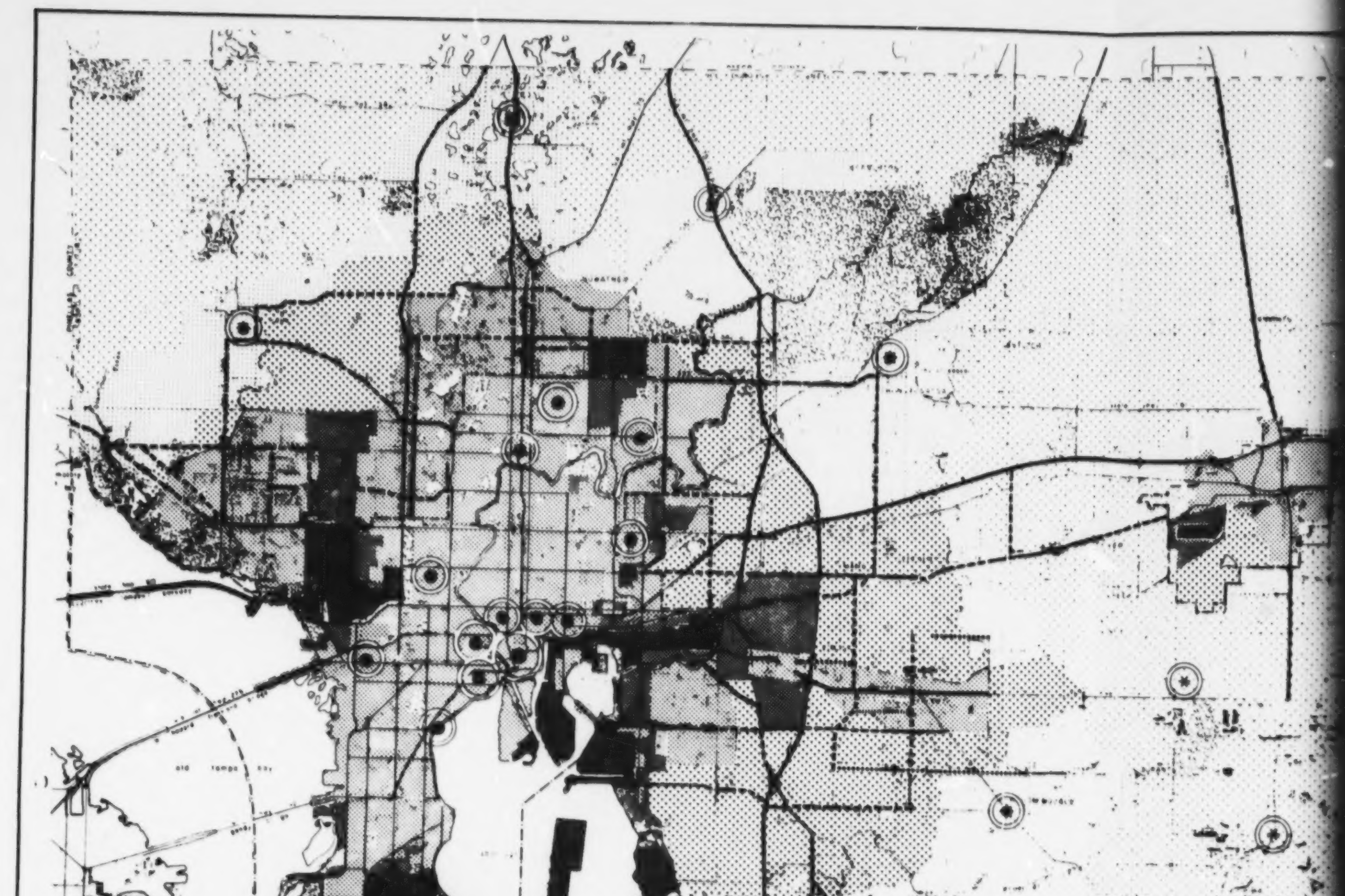

8H131
8H126
8H168
8H172
Alafia River
8H116, 17, 18, 19, & 20
Gibsonton
8H152
8H153
8H122
Gardensville
8H125
Bullfrog Creek
301
MacDill Air Force Base
Hillsborough Bay
41
8H149 & 50
8H136
8H154
8H135
Adamsville
8H173
8H1102
8H155
8H1101
8H156
Big Bend Station
8H157
Big Bend Road
8H165
8H175
8H1100
Apollo Beach
North Ruskin
Tampa Bay
8H156
Seaboard Coast Line
41
5-mile radius
301
Ruskin
Town boundaries - - - - - -
0
1
2 Miles

Figure 5-66. Archaeological sites in the vicinity of Big Bend Station (Sheet 1 of 2).

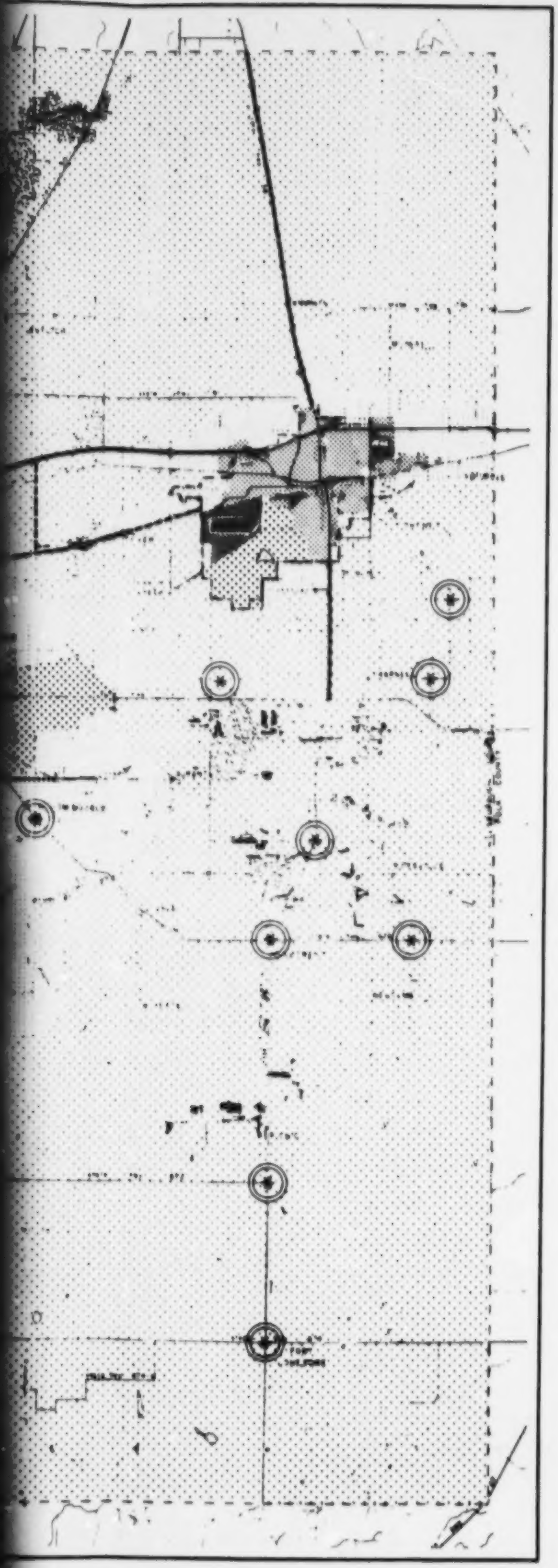
NO.	LOCATION	DESCRIPTION
8H116	Millpoint 1	Shell midden, mostly destroyed, 8ft high, flexed burials, no artifacts, *Moore, 1900*
8H117	Millpoint 2	Sand ridge, no material listed, *Moore, 1900*
8H118	Millpoint 3	Sand mound, some human bone, *Moore, 1900*
8H119	Millpoint 4	Sand mound (domiciliary), *Moore, 1900*
8H120	Millpoint 5	Sand mound, *Moore, 1900*
8H122	Shell Bluff	Burial mound, flexed burials, no artifacts, *Moore, 1900*
8H125	N/N	Sand pit on edge of mangrove flat, glades plain
8H126	N/N	Cemetery, partially in oil refinery, *Bullen, 1951*
8H131	Old Shell Point	Shell mound, shell hauled off for fill, only remains are around tree bases, *Plowden, 1952*
8H135	N/N	Shell mound, good condition, *1952*
8H136	Adamsville	Shell mound, good condition, *1952*
8H149	N/N	Sand mound, *Bullen, 1952*
8H150	N/N	Shell mound, *Bullen, 1952*
8H152	N/N	Sand mound, *Bullen, 1952*
8H153	N/N	Sand mound, *Bullen, 1952*
8H154	N/N	Shell-capped sand mound, *Bullen, 1952*
8H155	N/N	Sand mound, much lowered by cultivation, *Bullen, 1952*
8H156	Lincoln Mound	Sand mound, shell capped, larger than others in complex of 54-55-56, 12 ft high, *Bullen, 1952*
8H157	N/N	Sand mound, light capping of shell, *Bullen, 1952*
8H158	N/N	Two large sand mounds, *Bullen, 1952*
8H165	Big Bend	Shell mound, destroyed, mangroves have taken it over, *Bullen, 1952*
8H168	Palm Cia Springs	Flint and sherd area, *1952*
8H172	N/N	Shell midden, in heavy hammock, *1952*
8H173	N/N	Sand burial mound, badly noted, *1952*
8H175	Simmons Mound	Burial mound, cut down by disking, *1952*
8H1100	Apollo Beach	Dredged, transitional period, *Bullen, 1952*
8H1101	Elsberry site	Buried shell midden, safety harbor, exposed by drainage ditch, *Bullen, 1952*
8H1102	Cooley site	Completely eroded by waves, human bone and sherds on surface, transitional, *Bullen, 1952*

Note: Identification numbers have been assigned by the State Division of Archives, History, and Records Management.

Figure 5-66. Archaeological sites in the vicinity of Big Bend Station (Sheet 2 of 2).



Hillsborough County Planning Commission



Proposed Land Use Designations
Urban development area (Estimated occupancy ratio 95%)
Urban high density nodes
Urban transition development area (Estimated occupancy ratio 65%)
Suburban development area (Estimated occupancy ratio 40%)
Suburban activity center
Rural development area (Estimated occupancy ratio 15%)
Rural activity center
Light industrial
Heavy industrial
Major public
Major public open space
Preservation - inland
Preservation - water
Proposed electric power plant site
Water
0 1 2 3 4 5 MILES

Figure 5-67. Hillsborough County generalized land-use map for year 2000.

5.7 TRANSPORTATION

5.7.1 HIGHWAYS

Federal, state, and county highways are the primary transportation arteries in Hillsborough County. In the northern half of the county, the highway system is quite extensive, particularly around Tampa. Interstate, state and U.S. routes connect Hillsborough County with the surrounding counties of Pasco, Pinellas, and Polk. In the southern half of the county, the only primary highways are U.S. 41 and U.S. 301, both of which parallel the Tampa Bay coastline (Florida Department of Transportation 1975). These routes pass east of the Big Bend Station at a distance of 1-1/2 and 4 miles, respectively (Tampa Electric Company 1979c).

In the Horizon 2000 transportation circulation plan, the county has projected an extension of I-75 to the south. Upon completion of the extension, this four-lane expressway will run between U.S. 41 and U.S. 301 and will pass approximately 2-2/3 miles east of the Big Bend Station (Hillsborough County Board of County Commissioners 1978). U.S. 41 and Big Bend Road provide auto and truck access to the plant site. U.S. 41 is a four-lane divided highway with a present (1979) average daily traffic flow (two-way combined) of 20,990 vehicles at a point just south of Big Bend Road (Mr. Ronny Price, Florida State Department of Transportation, Bureau of Planning and Traffic Counts, personal communication, May 12, 1980).

5.7.2 RAILROADS

All railroads within Hillsborough County are owned by the Seaboard Coast Line and the trains mainly carry freight. As with the county highways, railroad tracks in the southern half of the county are limited, and only two stretches of track, running in a north-south direction, connect the county railroad system to that of its southern neighbor, Manatee County. One of these two tracks passes 1-1/2 miles to the east of Big Bend Station and spurs from this line serve the station (Tampa Electric Company 1979c).

5.7.3 BUS SERVICE

Bus service in the county is provided by the Tampa Lines bus company. Full service is available in Tampa, but the remaining portions of the county receive only limited service. U.S. 41 is planned for line-haul bus service between 1977 and 1985 (Tampa Bay Regional Planning Council 1977).

5.7.4 AIR TRANSPORTATION

There are presently seven general aviation facilities in Hillsborough County. Tampa International Airport is the only airport in the county providing commercial passenger service (Hillsborough County Board of County Commissioners 1978). The airport handles interstate and intrastate commercial passenger and freight service and international flights to Mexico (Tampa Bay Regional Planning Council 1977; Greater Tampa Chamber of Commerce, undated-a).

Projections of future demand against present capacity at these facilities indicate that three airports (Tampa International, Peter O. Knight, and Vandenberg) will have demand in excess of capacity by 1990. Facilities analysis has revealed the need for increased capacity to the east of Tampa and the possibility of a new facility in northwest Hillsborough County (Hillsborough County Board of County Commissioners 1978).

There are no commercial or municipal airports located in the southern portion of the county. Although there are three private airstrips in this region, none of these are located within a 5-mile radius of Big Bend; the closest is approximately 10 miles southeast of Big Bend Station (Florida Department of Transportation, undated).

5.7.5 PORT OF TAMPA

The Port of Tampa is the eighth largest port in the United States (Tampa Bay Regional Planning Council 1977). The total tonnage passing through the port has increased from 41.5 million tons in 1974 to over 48 million tons in 1978 (Hillsborough County Board of County Commissioners 1978; Booz-Allen and Hamilton, Inc. 1979). The major commodities flowing through the Port of Tampa are phosphate rock, petroleum, and sulfur (Stanford Research Institute 1968). The port is primarily a bulk port (Stanford Research Institute 1968), with general cargo accounting for only 3 percent of the total tonnage in 1978 (Booz-Allen and Hamilton, Inc. 1979). Despite this, general cargo accounted for 24 percent of the port's economic value.

Phosphate is the principal cargo the port handles (Stanford Research Institute 1968). Since 1960, the port's phosphate shipping has accounted for more than one-third of Florida's marketable phosphate production (Stanford Research Institute 1968). Petroleum is the second most important cargo, followed by liquid sulfur and coal (Hillsborough County Board of County Commissioners 1978). Tables 5-123 and 5-124 provide data on past and future port tonnage.

Total tonnage for the port is projected to reach 70 million tons by 1990 and 97 million by the year 2000 (Hillsborough County Board of County Commissioners 1978), and port facilities will have to be upgraded and expanded to accommodate the additional tonnage. The Port Authority plans to assist the private sector in modernizing the facilities by issuing special purpose, tax-free municipal bonds and by providing statistical business and economic forecasts (Hillsborough County Board of County Commissioners 1978).

In order to accommodate larger and more fully loaded vessels in the future, a channel improvement program will be necessary. The Tampa Harbor Deepening Project, authorized by Congress in 1970 and scheduled for completion in 1983, involves the deepening and enlargement of the main ship channels in Tampa Bay from the Gulf of Mexico to Upper Hillsborough Bay. Recently, however, the project has been the subject of much criticism. Many persons are concerned about the availability of adequate spoil areas for the dredging of Port Tampa Channel, the cost of dredging and disposal, and degradation of the water quality in Tampa Bay (Tampa Bay Regional Planning Council 1977).

Table 5-123. Total tonnage handled at the Port of Tampa, 1962-1978[a]

Year	Tonnage[b]
1962	15,427
1966	24,264
1970	32,382
1974	41,509
1978	48,232

[a] From Hillsborough County Board of County Commissioners (1978) and Booz-Allen and Hamilton, Inc. (1979).

[b] In thousands of tons.

Table 5-124. Principal commodities of the Port of Tampa, past and projected[a]

	Tonnage[b]	
Commodity	Year 1974	Year 2000
Phosphate	23.5	37
Petroleum	11.5	20
Sulfur	3.9	11
General	1.4	2

[a] From Hillsborough County Board of County Commissioners (1978).

[b] In millions of tons.

5.8 AESTHETIC QUALITIES

TECO currently owns or has purchase agreements on approximately 1,675 acres in west-central Florida in Hillsborough County. Over 60 percent of the land owned or under purchase agreement by TECO has in some way been influenced by human activity. The area immediately south and southwest of the existing station, which consists of mangrove swamps, is the most important natural area of the Big Bend site. It has been proposed that these swamps be given permanent protection by the State (E. Tobie, Environmental Protection Commission of Hillsborough County, personal communication).

The plant site area itself is low flat, filled land projecting into Hillsborough Bay. The only vegetation in the plant area is the landscaping associated with Units 1, 2, and 3. The built environment is dominated by the existing generating units. The main visual elements of this scene are the imposing twin stacks, the lower but massive turbine buildings, and the coal-handling equipment that extends over a large area adjacent to the main buildings. An artist's conception of Big Bend Station is presented as Figure 5-68.

The land area within a 5-mile radius of the Big Bend site contains no distinctive natural or man-made features and no officially recognized scenic resources. This area is primarily flat, the land surface gradually rising from sea level at the Hillsborough Bay shoreline to a height of just over 80 feet at the eastern edge of the 5-mile area. The gentle slope of the land is broken only by the more rapid changes in elevation occurring at stream banks and by small hills above the eastern bank of Bullfrog Creek.

Vegetation is sparse within this area, having been largely cleared for grazing and crop production. Most remaining growth lies along stream banks, drainage ditches, and the shore of Hillsborough Bay, where substantial mangrove swamps are found. Where the vegetation occurs it is generally quite dense, often evergreen, but not of great height. For this reason it serves as an effective visual barrier to low, nearby features but does little to limit visibility of tall or distant objects.

The built environment within this area is characterized by strip commercial and residential developments along the highways, a few new residential subdivisions, and some industrial facilities along the bay shore north of Gibsonton. Although the newer planned residential subdivisions have been aesthetically developed, most of the built environment has limited visual appeal. The roadside strips are dominated by jumbles of homes, shops, fruit stands, signs, and deteriorated housing. The existing industrial area north of Gibsonton contains one of the most prominent visual features in the area--a large pile of phosphate tailings.

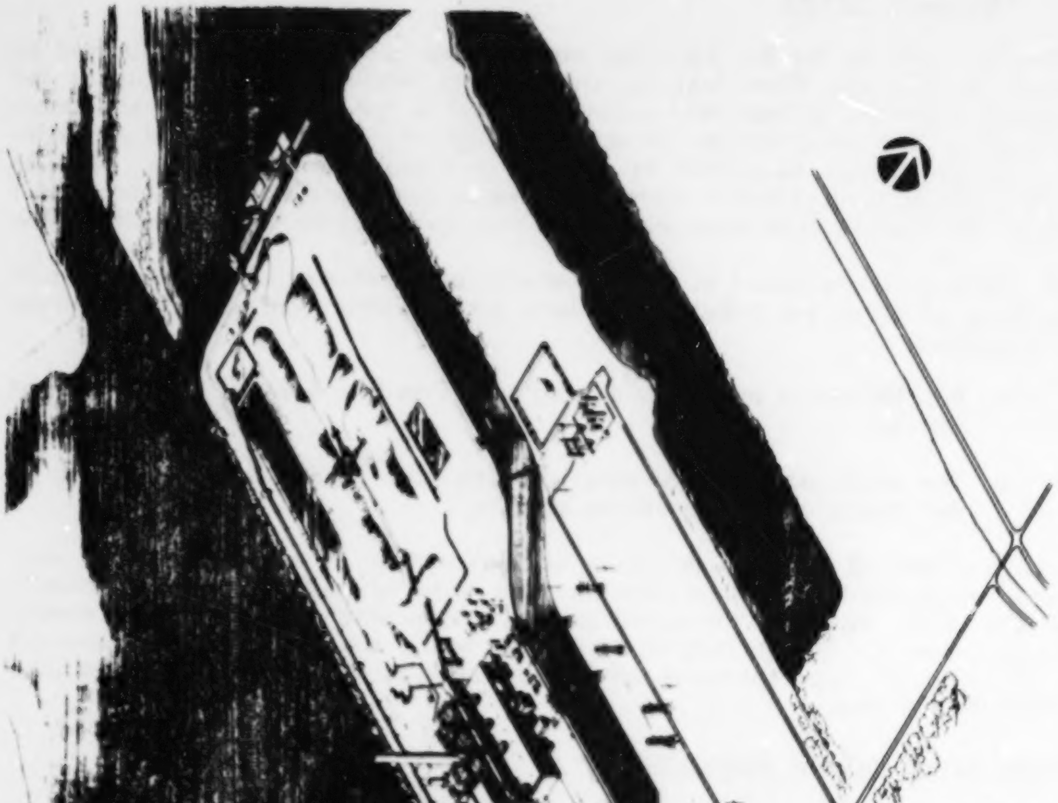


Figure 5-68. Artist's view of the Big Bend Station.

5.9 SENSITIVE AREAS

Sensitive areas on the Big Bend site include those areas previously influenced by human activity and those that are important to wildlife. Therefore, all of the existing 267 acres of relatively undisturbed land on the site are potentially sensitive areas. This would include 152 acres of mangrove swamps, 54 acres of palmetto-pine-Juncus (typical flatwoods), 41 acres of salt prairie or dry prairie, 11 acres of naturally occurring ponds, 4 acres of freshwater marsh, and 6 acres of intermittent beach. The importance of these habitats has been previously discussed in Section 5.2.4.

The siting of a powerplant in an area where karst features, closed depressions or sinkholes, or caves, are present would have the following significant environmental consequences:

- o Possible loss of foundation support due to sinkhole development in the karst terrain.
- o The likelihood of ground-water contamination from coal stockpiles and fly ash disposal on complex karstic aquifers.

A large portion of Hillsborough County is characterized by stable, prehistoric sinkholes, which are usually flat-bottomed, steep-sided, and either dry or waste-laden (Wright 1974). However, the actual plant site is located on artificial fill recently dredged from the bottom soils of Tampa Bay and is not considered to be sinkhole prone. Also, the Applicant has determined that no karst features have been identified within the site area.

Areas Having National Recognition

As discussed in Section 5.6, there are no National Register historic sites or national natural landmarks within 5 miles of the Big Bend site. This area includes both the plant site and all associated transmission facilities.

The Florida Department of State Division of Archives, History and Records Management, was requested by TECO to undertake a survey of cultural resources within the area proposed for Big bend Unit 4. Their findings are discussed in Section 5.6. The Division concluded that the proposed development was unlikely to affect any sites listed or eligible for listing on the National Register.

A review of historic sites recorded in Hillsborough County by the State of Florida also determined that there are no historic structures within the site area.

5.10 RELATIONSHIP OF PROPOSED PROJECT TO OTHER LAND-USE PROJECTS

The Tampa Bay Regional Planning Council (TBRPC) was contacted to determine whether any other major land-use projects either exist or are being planned for the Big Bend project area. The TBRPC is the designated local A-95 review coordinator, and as such, has knowledge of all Federal and federally funded projects within its planning area. In addition, the TBRPC conducts reviews of other local projects not involving Federal funds.

Based on this contact, it appears that there is only one project which would interact with the proposed Big Bend Unit 4. This project is the Improvement and Maintenance of Big Bend Channel being undertaken by the U.S. Army Corps of Engineers. The project would extend the Tampa Harbor Deepening Project to the Big Bend site (Ms. Veronica Aikens, Tampa Bay Regional Planning Council, personal communication, May 28, 1980), and it would give the Corps of Engineers maintenance responsibility for the Big Bend Channel (Hillsborough County Board of County Commissioners 1978). The project is presently in a study phase that will last approximately 3 years (Mr. Bill Fehring, Tampa Port Authority, personal communication, May 29, 1980). During this phase, the necessary extent of channel deepening, turning basin enlargement, and main channel widening will be determined. At present, the Big Bend Channel is 34 feet deep, and it may be deepened to as much as 43 feet (Mr. Bill Fehring, Tampa Port Authority, personal communication, May 29, 1980). The channel deepening would allow larger coal transport vessels to be used, thereby reducing the number of vessel trips. The timing and final specifications of this project will not affect the Big Bend project.

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Chapter 6

ENVIRONMENTAL IMPACTS OF THE PROPOSED PROJECT

6.1 PRIMARY CONSTRUCTION IMPACTS

The Big Bend Station is located on filled land and upland on the eastern shore of Hillsborough Bay. The total site occupies approximately 1,675 acres included in the plot plan, of which 800 acres are in use. Construction activities, including the erection of permanent structures and facilities, will directly affect approximately 41 acres (Figure 4-3). When completed, the Unit 4 turbine, boiler, precipitator, limestone storage and handling, and flue-gas-desulfurization (FSD) systems will occupy approximately 7 acres. In addition, an area of approximately 7 acres will be designated for the coal reserve and service facilities associated with Unit 4. One hundred and twenty-one acres of land will be used for an ash-settling pond system and approximately 97 acres as a storage and disposal area for gypsum, the by-product flue-gas desulfurization. An existing percolation/evaporation (P/E) wastewater pond with a spray-irrigation field occupies about 40 acres and will not require enlargement.

The Applicant has stated (Tampa Electric Company 1980a) that a mechanical-draft cooling tower may be required as the waste-heat rejection system for Unit 4. The conceptual location for the tower (bottom diameter of 81 meters, or 265 feet) is directly south of the Unit 4 plant structure on the southern bank of the discharge canal, just west of the bottom-ash pond and Beach Road (Figure 4-3).

6.1.1 ATMOSPHERE

6.1.1.1 Air Quality

The construction of the proposed project will require a period of approximately 38 months. During this period, the ambient air quality in the vicinity of the site will be modified, the extent of this impact depending on the nature of the construction activities. Fugitive dust will be raised from untreated or unpaved road surfaces or unvegetated areas during dry, high-wind-speed conditions and during the movement of heavy construction equipment. The dust will be controlled by spraying, surfaces with water, chemical treatment, and/or other measures described in Section 7.1.1.

The concentrations of nitrogen oxides, carbon monoxide, suspended particulates, sulfur dioxide, and hydrocarbons will increase, because these pollutants will be emitted by the engine exhaust of construction equipment and automobiles used by the construction work force. Proper maintenance of construction vehicles and equipment will help reduce any impact on air quality by vehicular exhaust emissions.

6.1.1.2 Noise

Estimates of the noise from construction of Unit 4 are explained in Section 4.2.11. Construction activities will generally occur during the daylight hours, and even the predicted peak-construction sound levels should be below the maximum permissible sound level of 60 dBA specified in the Hillsborough County noise code for daytime in residential areas (1976). At all locations except Location 6 (Figure 5-9), construction sound levels should in fact be lower than existing residual ambient sound levels. (A "residual" sound level is one that equals or exceeds the sound level occurring in an area 90 percent of the time.) At Location 6, the residential area nearest the site, normal and peak construction sound levels should be approximately 4 and 12 decibels higher than the residual ambient levels, respectively. Variations in ambient sound levels presently occur, however, because of variations in existing sources of ambient noise (Section 5.1.3). Therefore, nearby public and private areas should not be adversely affected by onsite construction noise.

6.1.2 LAND

The primary impacts associated with the construction of Unit 4 will include the commitment of approximately 41 acres of land for craft parking, equipment laydown, construction workshops, the temporary storage of excavated material, and the erection of the buildings that comprise and are associated with Unit 4 (Tampa Electric Company 1980b). Unit 4 plant structures will require approximately 7 acres of land. Approximately 7 additional acres will be designated for the coal reserve and service facilities associated with Unit 4. Much of the area that will be temporarily committed to laydown, craft parking, and the storage of excavated material will be restored during construction activities or after their completion. All of the acreage slated for construction activities was previously disturbed during the construction of Units 1, 2, and 3. A new, permanent railroad spur will also be constructed in this previously disturbed area.

This area, designated as the Power Station Vegetation Type (Type 1) in terrestrial studies conducted at the site (Section 5.2.4.1), contains primarily herbaceous, low-growing vegetation typical of disturbed areas in the early stages of secondary succession. These species rapidly become established on disturbed lands and are commonly found within the region. Therefore, the clearing of this disturbed area will not represent a lasting adverse ecological impact. Clearing and construction activities will result in a displacement or elimination of all sedentary animal species (mainly small mammals) that may presently inhabit this area. This is not considered an important long-term ecological impact, because these species most likely exist in more stable populations in nearby less disturbed areas.

More mobile animal species, such as birds and large mammals, which may occasionally enter this area, will tend to avoid it during the construction period. Since this area does not represent an important habitat for locally occurring animal species, its use for construction-related activities does not constitute an important loss of wildlife habitat.

In addition to the 41 acres previously described, approximately 97 acres will be preempted by storage and disposal sites for the FGD by-product gypsum. These 97 acres consist of approximately 66 acres of pastureland (including a small pond of less than an acre and the associated marsh) and 31 acres of agricultural land.

The pastureland consists primarily of ruderal or weedy species of herbaceous vegetation. At the time of ecological surveys conducted in 1977, this land was no longer being used as a cattle-grazing area. The 1974-1975 surveys showed that the pasture and pond/marsh areas supported a relatively small number of vertebrate species in comparison with less disturbed habitats at the Big Bend site. The species inhabiting the pasture included the hispid cotton rat, the marsh rice rat, the eastern cottontail, the marsh rabbit, and certain field- and marsh-dwelling birds. The 1977 survey indicated that most of the pasture pond had disappeared and vegetation was more typically of the old-field type (i.e., drier) rather than marshland. There was also an increase in vertebrate species preferring old-field habitats and a sharp decrease in the number of marshland species; marsh birds were notably absent from the area. The 31 acres of agricultural land represent supplemental sources of food and cover for wildlife, but their availability depends on the types of crops planted and the frequency of tillage.

The development of the proposed gypsum storage and disposal area represents a long-term commitment of these pasture and agricultural lands. However, the commitment of these plant communities and wildlife habitats is more ecologically acceptable than that of other available parcels at the Big Bend site because of the following:

1. These habitats have been recently disturbed and are not unique to the Big Bend site or to the surrounding area.

2. They are among the least biologically important wildlife habitats at the site.

The ash-disposal pond system for Unit 4 will require the preemption of 121 acres of land. The bottom-ash pond will be located in the area currently occupied by an unused U-shaped cooling pond (Figure 5-14). The fly-ash pond will be adjacent to the bottom-ash pond on land that was classified as "old field" in the terrestrial studies conducted at the site (Tampa Electric Company 1980b).

The only construction associated with the transmission lines for Unit 4 will be the installation of an additional 230-kilovolt circuit on the existing power line. There will be no need for a new right-of-way. Land areas beneath the transmission line (1) are zoned for industrial use, (2) do not include critical wildlife habitat, and (3) do not require the presence of man-made structures or alterations of existing topography. Vegetation may be disturbed temporarily by vehicles carrying equipment, but since this will not affect mature forest or important flora, irreversible impacts are not expected. Erosion problems are not expected to occur; however, should any problems develop, mitigation will be effected by the use of mulch, temporary or permanent vegetation, or erosion-control fabrics.

Dredge spoils resulting from Unit 4 construction and maintenance activities will be disposed of at either or both of the dredge disposal areas shown on Figure 6-1. These are existing disposal areas that have been used for Units 1-3. The northeast disposal area is composed of three cells and occupies an area of approximately 22 acres. The large cell is enclosed by earthen dikes that rise 20 feet above grade. The two smaller cells are diked to an elevation of 15 feet. The south disposal area is enclosed by a 20-foot dike and covers approximately 45 acres.

Dredging associated with the construction and installation of the Unit 4 cooling-water intake and discharge structures involves only a small amount of spoil material. This will be removed by clamshell and trucked to the disposal areas. No discharge from the disposal areas is expected.

The conceptual location for a mechanical-draft cooling tower is directly south of the Unit 4 plant structure on the south bank of the discharge canal, just west of the bottom-ash pond and Beach Road (Figure 4-3). The Applicant has stated that the tower would be placed in a location that would minimize impacts on the nearby mangrove area (Tampa Electric Company 1980a).

The sound levels produced by construction equipment and related activities represent a potential source of impact on wildlife in the vicinity of Big Bend Station. The ambient sound levels and those predicted to occur during construction of Big Bend Unit 4 are presented and discussed in Section 4.2.11.

The assessment of construction-noise impact on wildlife is based largely on the investigation reported by Fletcher and Busnell (1978) at a state-of-the-art symposium. A summary of this symposium included the observation that "there is not overwhelming evidence that noise is not a significant adverse factor in the life of animals. But neither is there clear definitive data demonstrating that noise is an adverse stimulus or stressor [to animals]."

Responses of vertebrate fauna to construction noise may vary from species to species and will depend on the distance of the organisms from the powerplant complex and from other intrusive noise sources. Species nearest the plant may experience periodic "startle reactions" and move away from the noise source (if possible) when peak-construction sound levels occur; however, most of the species occurring nearest the site are expected to have adjusted to the existing noise resulting from the operation of Units 1, 2, and 3. Many of these organisms (e.g., raccoons, mice, rats, rabbits, and several bird species) coexist with people and typify the habituation of animals to human activities and the accompanying noise (Fletcher and Busnell 1978).

Except for organisms inhabiting the FGD gypsum storage and disposal area, animals occurring in other areas distant from the plant (e.g., at noise measurement locations 4 through 8, Table 4-15) should experience little, if any, increase in ambient noise levels during construction. For this reason, no measurable effects of construction noise on organisms occurring near or beyond these locations are expected.

Site restoration will begin during the latter stages of construction or upon its completion. Certain areas will be surfaced with crushed stone to maintain areas frequently used by maintenance personnel and heavy equipment. Trees, shrubs, and ground cover will also be planted. The vegetation will be selected to satisfy three primary objectives: (1) the stabilization of soils, (2) the creation of an aesthetically appealing physical plant and surrounding area, and (3) the establishment of wildlife habitat and food sources.

The plant species that have been tentatively selected were chosen from among those native to the Big Bend site and from among those exotic species that will ecologically and aesthetically complement the naturally occurring species (Table 6-1). Whenever practical, trees and shrubs will be transplanted from within the Applicant's property to areas undergoing site restoration.

An increase in the use of heavy equipment and the storage of building supplies on the site may result in erosion, soil compaction, and the alteration of surficial soil characteristics. However, the dredge-and-fill soils will show few signs of construction impact in addition to those of earlier construction activities. The adverse effects of compaction and surficial soil alteration on cultivated lands and pasturelands that are used only temporarily can be reversed during the revegetation phase.

6.1.3 WATER

Since the Unit 4 construction site is situated on dredge fill consisting primarily of sand and shell material, the soil is generally highly permeable. Although the site area has been stripped of most vegetation, some isolated areas of grass still exist. The main plant road is paved, but other construction roads are not. The primary surface-water impacts potentially resulting from site excavation and construction include local ponding, increased erosion, and degradation of storm-water runoff. There will be no discharge of runoff water potentially degraded by construction activities. Surface runoff will be intercepted and pumped to the wastewater-treatment pond (Tampa Electric Company 1981a). The mitigative measures that the Applicant will use to control these impacts are described in Section 7.1.2.1.

Construction associated with the erection of the Unit 4 discharge structure will have a primary impact on the aquatic environment. The discharge structure will be located in the 350-foot-wide plant discharge canal east of the existing Unit 3 structure (Tampa Electric Company 1980a). Approximately 690 cubic yards of sand and silt will be dredged from an area extending 80 feet in the canal, with an end width of approximately 65 feet and tapering to approximately 24 feet at the existing bulkhead. The discharge structure will be constructed of steel sheet pile and will consist of two diverging walls approximately 50 feet long. When these walls are in place, a clamshell bucket will be used to dredge the material from between the walls. A silt barrier will be maintained during the operation. A tremie concrete floor (trapezoidal, 12 by 50 by 36 feet) and a rip-rap apron will be constructed to protect the bottom of the canal from erosion by the discharge flow. It is estimated that 3.2×10^6 benthic invertebrates would be destroyed by removal in the dredge material. This calculation is based on a mean density of 10,111 individuals per square meter living in the sediment to a depth of approximately 10 centimeters. This is the average of the mean densities found at Station I-1, the site of Unit 3 discharge (Figure 5-36), during studies conducted from May 1976 to April 1977 (10,056 individuals per square meter: Mahadevan et al. 1977; Mahadevan and Culter 1978) and from May 1979 to December 1979 (10,166 individuals per square meter: Mahadevan, Culter, and Yarbrough 1980). Previous studies have indicated that the benthic community in the discharge canal is dominated by species that are classified as opportunistic or as characteristic of thermally stressed areas (Mahadevan et al. 1977; Mahadevan, Culter, and Yarbrough 1980).

It is expected that the fish inhabiting the discharge canal would avoid areas of activity and would return after construction is completed. Manatees congregate occasionally in the warm waters of the discharge canal during the winter months. Discharge construction activities will be scheduled for months of the year when construction would result in minimal interference with the activities of this endangered species.

The intake structure for Unit 3 will be extended to provide for the Unit 4 circulating-water pumps. Approximately 420 cubic yards of sand and silt will be dredged from an area 50 by 55 feet to accommodate the structure. The Applicant has stated that, during construction, applicable water standards will be maintained by using a silt barrier or other technologies (Tampa Electric Company 1980a).

During the construction period, the ground-water elevations in the immediate vicinity of Unit 4 will be lowered by the gravity dewatering system required for earthwork. The potentiometric surface (Figure 6-2) of the affected ground water, established in previous field-dewatering tests, indicates that this dewatering activity should not have any noticeable effects on private or agricultural wells in the area, either in the available quantity or in the quality of water. Since the construction site is on a narrow peninsula, the quality of ground water in the area is strongly affected by, and similar to, the quality of bay water. The construction-dewatering effluent will be discharged to the intake and discharge canals (Section 6.3.3.1.2). If this effluent is found to be high in suspended solids, the Applicant will use appropriate methods of silt control. After construction is complete, the dewatering system will no longer be needed and ground water will be allowed to rise to its original natural elevation (Tampa Electric Company 1980b).

The construction of the bottom- and fly-ash disposal pond areas will require the relocation of Jackson Branch from its current course to one east and north of the perimeter of the disposal pond areas (Figure 4-15; Tampa Electric Company 1980a). Approximately 2,400 feet of channel will be bypassed and filled, and 2,900 feet of new channel will be constructed. This will require filling approximately 15,250 cubic yards of the old channel. The new channel will be approximately 15 feet wide and will be constructed to have a similar cross-sectional area, side slopes, and depth (and a slightly flatter channel slope) as the old channel. The new channel will tie into the existing Jackson Branch just south of the bridge on Big Bend Road. Cut material from the new channel will be used to fill the old channel or will be placed in upland disposal sites. Material will be excavated by dragline. The relocated portion of the stream bed initially will have a substrate of disturbed naturally occurring material, predominantly shelly sand. The stream bank will be allowed to revegetate naturally and is expected to resemble portions of the present stream bed after a few years. The productivity of the relocated portion of the stream will be decreased appreciably; however, since the stream area inflow is small, it is expected that this loss of productivity will not have an observable effect on the Tampa Bay system. The ash-disposal pond areas will be diked for the 100-year flood and precipitation will be retained within the dikes; therefore, direct runoff into the relocated Jackson Branch channel will be controlled.

With regard to Newman Branch and the construction of the FGD by-product storage and disposal areas (Phases I through IV), there will be no construction activities associated with the main channel of Newman Branch (Tampa Electric Company 1980a). Small drainage swales and ditches (Figure 4-15), previously constructed to drain the area for agricultural use, will be filled before and during the period in which this area is used as a gypsum storage and disposal site. These swales are triangular and on the average less than 5 feet wide and 1 foot deep. Approximately 38,000 linear feet of these swales will be filled within the 97-acre FGD by-product area. Filling of these swales and ditches will occur during and as a result of the general earthwork activities associated with dike construction and general site preparation. The FGD by-product storage and disposal area will be diked for the 100-year flood, and precipitation will be retained within the diked area. Therefore, storm-water runoff from this area into Jackson Branch will be controlled. These swales and ditches are nontidal. Since these drainage swales and ditches are intermittent water courses, it is expected that there will be little or no impact on the biota of Newman Branch or Tampa Bay as a result of their removal.

Dredge spoils resulting from Unit 4 construction and maintenance activities will be disposed of at either or both of the dredge-disposal areas shown on Figure 6-1 (Tampa Electric Company 1980a). These are existing disposal areas that have been used for Units 1, 2, and 3. The northeast disposal area consists of three cells and occupies an area of approximately 22 acres. The largest cell in this area is enclosed by earthen dikes that rise 20 feet above grade. The two smaller cells are diked to an elevation of 15 feet. The south disposal area is enclosed by a 20-foot dike and covers approximately 45 acres.

The dredging associated with the construction and installation of the Unit 4 cooling-water intake and discharge structures will result in 1,110 cubic yards of spoil material which will be removed by clamshell and trucked to the disposal areas. For this activity, no discharge from the disposal areas is expected.

The earthwork needed for relocating Jackson Branch and constructing the bottom-ash, fly-ash, and FGD by-product disposal areas will be done by dragline, bulldozer, or similar methods. Material cut during the construction of the new channel for Jackson Branch will be used to fill the old channel. Any excess cut material not used in filling the old channel or in the construction of the perimeter dikes around the bottom-ash, fly-ash, or FGD by-product disposal areas will be disposed of in the dredge-spoils disposal areas. Most of this material will be relatively free of water, and thus no discharge from the spoils-disposal areas is expected.

Maintenance dredging has been performed at Big Bend in the past, and it is conceivable that some maintenance dredging for Unit 4 will be necessary in the future. Depending on the location and volumes, either clamshell or hydraulic dredging will be performed. At present, when material is hydraulically dredged to the disposal areas, overflow is discharged to the bay via the local canals. Effluents from the northeast disposal area are discharged to the canal north of the combustion turbines. Effluents from the south disposal area discharge into the canal immediately south of the area. Overflow from the process, other than being slightly more turbid, is similar to bay water. Adjustable flashboard risers and silt barriers are used for the control of effluent water quality (Tampa Electric Company 1980a).

The mitigative measures that are proposed to prevent or minimize the adverse effects of construction activities on surrounding water bodies are described in Section 7.1.2.

6.1.4 PEOPLE

6.1.4.1 Socioeconomics

The construction of the proposed Big Bend Unit 4 is scheduled to commence in February 1982 and terminate in 1984. This section concerns the socioeconomic impacts of the construction of Unit 4 on the site and on the surrounding area of Hillsborough County.

6.1.4.1.1 Employment

It is estimated that an average of 514 construction workers (craft and nonmanual) per year will be required during the 3-year construction period. A peak-construction labor force of approximately 980 persons will be needed for approximately 2 months during 1984, the third year of construction. The expected daily average labor force per year is given in Table 6-2.

From a survey of local union representatives (P. A. Boyer, Stone & Webster Engineering Corporation, personal communication, May 1979), it is expected that the majority of the craftsmen will be from Tampa and the surrounding communities, and that these will be supplemented with people from other areas during peak periods. It is expected that local people will constitute about 90 percent of the total construction labor force, depending on the level of other construction activity in the area at the same time (Tampa Electric Company 1980b). At the peak of construction, therefore, approximately 98 construction workers will have to relocate to Hillsborough County.

6.1.4.1.2 Wages of Construction Personnel

An estimated $11,800,000 (1982 dollars) will be paid to construction personnel over the 3-year construction period (Tampa Electric Company 1980b). Of this total, an estimated $10,018,200 will constitute disposable income if national characteristics prevail (U.S. Department of Commerce 1979). Most of the disposable income will be spent in the Tampa area, and this expenditure will substantially benefit the local economy.

6.1.4.1.3 Community Facilities and Housing

If it is assumed that each of the 98 relocating construction workers is accompanied by his family, and that the size of each family is consistent with the 1970 Florida average of 2.90 persons (U.S. Department of Commerce 1971), then the total number of persons relocating to the Tampa area as a direct result of construction would be 284, or less than 0.05 percent of the 1979 estimated total population of Hillsborough County.

The influx of relocating workers and their family members will not substantially alter the overall demand for housing and community services. Therefore, no special provisions for housing, education, or community facilities are expected (Tampa Electric Company 1980b).

The construction workers using community roads, schools, and health services will be predominantly local taxpayers. In any case, taxes on Big Bend Unit 4 will compensate Hillsborough County for the minimal additional demand for county services. The total annual property tax payments to Hillsborough County for Unit 4 will be approximately $3,700,000 (Tampa Electric Company 1980b).

6.1.4.1.4 Land Use

The residential developments nearest to Big Bend Station are at Apollo Beach (approximately 7,000 feet away), at the intersection of Big Bend Road and U.S. Highway 41 (approximately 6,000 feet away), and in the area known as Adamsville (approximately 7,200 feet away). Population in these areas is sparse. Except for occasional traffic congestion, plant construction is not expected to have an impact on these communities. Construction is also expected to have a negligible effect on nearby recreational facilities (Tampa Electric Company 1979).

Big Bend Unit 4 will be located on a site presently occupied by Big Bend Units 1, 2, and 3. Big Bend Station is designated to be a heavy industrial area in the year 2000 (Hillsborough County Board of County Commissioners 1978). Lands immediately adjacent to the station on the north, east, and southeast have been designated for industrial use. Currently, Big Bend Station and all of its associated facilities are zoned industrial (Tampa Electric Company 1979). Marshes and flood-prone areas within 5 miles of the site are expected to limit future development, thereby reducing the number of persons who may be directly affected in the future by Unit 4 (Tampa Electric Company 1979). Unit 4 is thus consistent with current and projected land-use patterns and practices, and it is generally expected that the facility will not adversely impact land use in the area.

The storage and disposal area for the FGD by-product gypsum will be developed according to a four-phase land conversion plan. By staged conversion, land will be developed only as the need arises, avoiding excessive land clearance. If developed in its entirety, the four-parcel storage and disposal area will occupy 97 acres and will consist of approximately 66 acres of pastureland (including less than 1 acre of ponds and associated marsh) and 31 acres of agricultural land (Tampa Electric Company 1980b).

Potential markets for the FGD gypsum, however, are currently being investigated. If the sale of gypsum is found to be feasible and markets are located, it is unlikely that all four parcels of land will be required for disposal. In addition, the long-term impact of the disposal areas will be offset at the end of the life of Unit 4, when the disposal areas are converted to public open space (Tampa Electric Company 1979).

6.1.4.1.5 Transportation

The most likely impact associated with the construction of Unit 4 will be the movement of workers, materials, and equipment to and from the Big Bend Station. Most of the traffic will reach the station from the north, via U.S. 41. An average of 550 vehicles will be traveling to and from the site each day during the peak-construction period of 1984. Of these 550 vehicles, an estimated 516 will be employee vehicles (assuming the carpooling of construction workers at a rate of approximately two persons per vehicle), 12 will be visitors' vehicles, and 22 will be trucks (Tampa Electric Company 1980b).

Currently, U.S. 41 is a four-lane divided highway with an average daily traffic flow (two-way combined) of 20,990 vehicles just south of the intersection of Highway 672 and U.S. 41 (R. Price, Florida Department of Transportation, personal communication, May 1980). As such, U.S. 41 will generally be able to accommodate the additional construction-related traffic (Tampa Electric Company 1980b). During the morning and evening periods of peak traffic flow, intermittent congestion may occur at the intersection of Big Bend Road and U.S. 41 and in the Adamsville residential area. The community of Apollo Beach may also experience periodic traffic congestions because of its proximity to the site. In this connection, it should be noted that Horizon 2000 projections for Hillsborough County include a "minimum highway network," which calls for a service level of "E" during periods of peak traffic congestion (Hillsborough County Board of County Commissioners 1978).*

Construction materials will be transported to the site by truck, rail, and barge. As with truck transportation, the impact of rail and barge transportation is considered to be negligible. An existing spur from the Seaboard Coast Line Railroad to the site will be used for the construction of Unit 4, and an additional spur will be constructed entirely within the site (Tampa Electric Company 1979).

The existing Big Bend Port can accommodate additional barges. Improvement of Big Bend Channel by increasing the depth to as much as 43 feet is currently under study by the U.S. Army Corps of Engineers. If approved, the channel deepening will allow larger coal-transport vessels. The project work itself will not interfere with the construction of Unit 4 (W. Fehring, Tampa Port Authority, personal communication, May 28, 1980).

6.1.4.2 Cultural and Historical Sites

The construction of Big Bend Unit 4 will not cause a relocation or direct physical disturbance of any historically or culturally significant sites in Hillsborough County (Tampa Electric Company 1980b).

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*Service level E is a classification applicable to roads on which traffic is typically "very congested." Such a classification prohibits lane changing on multilane roads and passing on two-lane roads.

6.1.4.3 Aesthetic Quality

The aesthetic quality of the site and surrounding area will not change dramatically during construction. Eighty percent of the Big Bend site has already been influenced by human activity. The area's landscape is dominated by the existing turbine buildings, the coal-handling equipment, and the twin stacks. The flat terrain contributes to the prominence of the existing units, as does the dense, but relatively low-lying, vegetation. The landscape within 5 miles of the Big Bend Station contains no distinctive natural or man-made features and few scenic attractions. The structures associated with Unit 4 will not significantly increase the visual or aesthetic impact of Units 1, 2, and 3, considering the size of the existing structures and the compatibility of the proposed unit with the industrial nature of the area.

There are, however, certain features of the facility and of the construction process itself that will have significant aesthetic impact. The development of the FGD by-product disposal area will have a long-term visual impact. This impact will be mitigated in part by vegetative screening at the periphery of the disposal area and in part by revegetating each parcel of the disposal area once that parcel has reached fill capacity. There will also be considerable activity, noise, and dust associated with the construction process. While these are only short-term conditions that will cease with the end of construction in 1985, some ad interim steps will be taken to minimize their overall effect on nearby residential and pastoral areas, as discussed in Sections 6.1.1 through 6.1.3.

The use of a mechanical-draft cooling tower to serve Unit 4 for waste-heat rejection would require a larger land area than that needed for the once-through cooling system. A cooling tower of this type is a structure of considerable size (diameter at the top deck is 87 meters, or 285 feet). However, the tower height (21 meters, or 70 feet) is considerably less than the height of other existing structures on the site (e.g., the stack height is 152 meters, or 499 feet). The aesthetic impact on surrounding areas is therefore not expected to be significant except for the possible visibility of the drift plume.

6.1.5 SENSITIVE AREAS

The only habitat on the Big Bend site considered to be ecologically sensitive or unique is the mangrove swamp south of the discharge canal. This swamp has been proposed for permanent protection by the Hillsborough County Environmental Protection Commission (E. Tobie, Hillsborough County Environmental Protection Commission, personal communication).

No permanent or temporary perturbations are expected in the mangrove swamp as a result of Unit 4 construction activity. All such activity will be confined to industrial land on dredge-and-fill spoils or other previously disturbed lands that are separated by a roadway and by water from the mangrove swamp.

The Applicant has stated that, should a cooling tower be required for Unit 4, the tower would be located to minimize impact on the nearby mangrove area (Tampa Electric Company 1980a).

6.1.6 TRANSMISSION-LINE CONSTRUCTION IMPACTS

As the only construction of transmission lines for Unit 4 will be the installation of an additional 230-kilovolt circuit on the existing power line, there will be no need for a new right-of-way. In addition, land areas beneath the transmission line (1) are zoned for industrial purposes, (2) do not include critical wildlife habitats, and (3) do not require the presence of man-made structures or alterations of the existing terrain. Vegetation may be disturbed temporarily by vehicles carrying equipment, but since this will not affect mature forest or important flora, irreversible impacts are not expected. Erosion problems should not occur; however, should any problems develop, mitigation will be effected by the use of mulch, temporary or permanent vegetation, or erosion control fabrics.

The only water to be crossed is the existing plant intake channel. No transmission structures have been or will be constructed within the channel. Unit 4 conductors will span the channel alongside existing conductors serving Units 1, 2, and 3.

In summary, no deleterious long-term impacts on land resources are expected, because an existing transmission-line right-of-way will be used. Only minor short-term disturbances like the loss of plants to trampling or soil compaction are expected.

Table 6-1. Vegetation selected for the conceptual site restoration at the Big Bend site[a]

Vegetation class/common name	Scientific name
Trees	
Wax myrtle	*Myrica cerifera*
Groundsel tree	*Baccharis halimifolia*
Live oak	*Quercus virginiana*
Cabbage palm	*Sabal palmetto*
Shrubs	
Oleander	*Nerium oleander*
Sea grape	*Coccoloba livifera*
Beauty berry	*Callicarpa americana*
Ground cover	
Bahia grass	*Papsalum notatum*
St. Augustine grass	*Stenotaphrum secundatum*

[a] Adapted from Tampa Electric Company (1980b).

Table 6-2. Average daily number of construction personnel required for Big Bend Unit 4[a]

Year	Nonmanual	General labor and crafts	Total
1982	40	290	330
1983	57	775	832
1984	55	325	380

[a] From Tampa Electric Company (1980b).

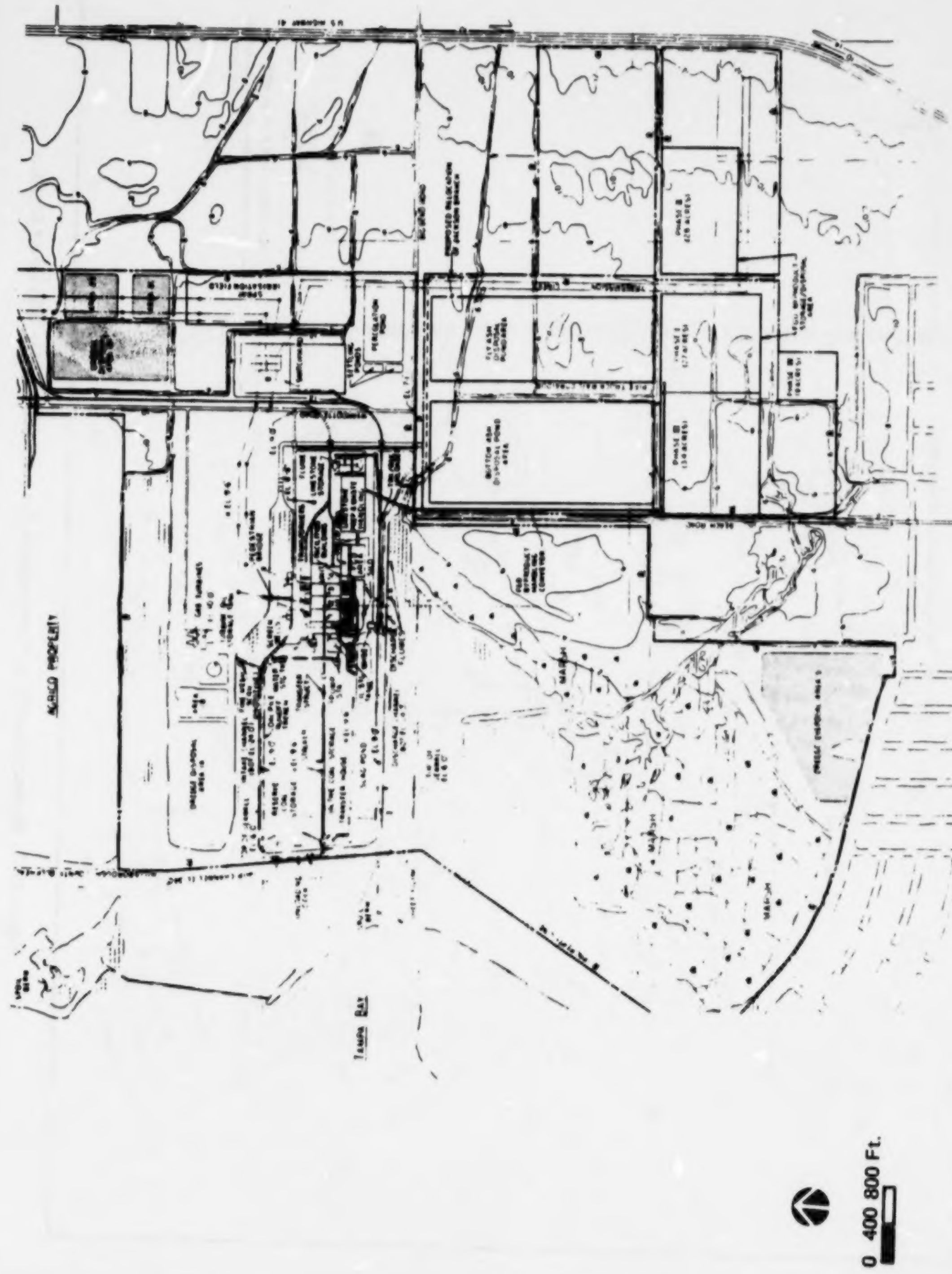
AGRICO PROPERTY
TAMPA BAY
MARSH
0 400 800 Ft.

Figure 6-1. Dredge-disposal areas, Big Bend site.

Source: From Tampa Electric Company (1980c).

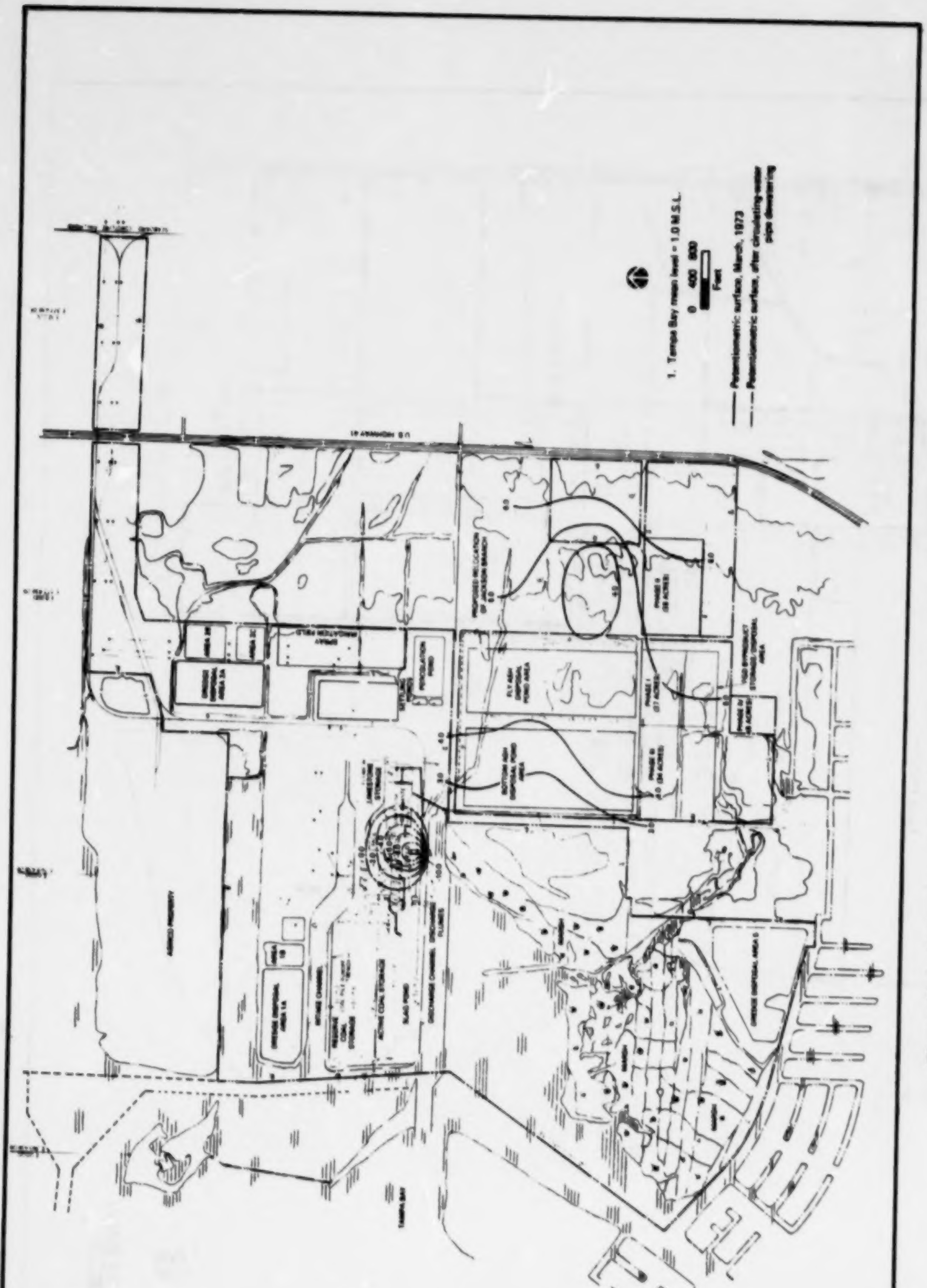
1. Tampa Bay mean level = 1.0 M.S.L.
0 400 800
Feet
Potentiometric surface, March, 1973
Potentiometric surface, after circulating-water pipe dewatering
U.S. HIGHWAY 41
TAMPA BAY
AGRICO PROPERTY
PERCOLATION POND
PROPOSED RELOCATION OF JACKSON BRANCH
FLY ASH DISPOSAL POND AREA
BOTTOM ASH DISPOSAL POND AREA
FGD BYPRODUCT STORAGE DISPOSAL AREA
SLAG PILE
ACTIVE COAL STORAGE
RESERVE COAL STORAGE
INTAKE CHANNEL
DISCHARGE CHANNEL
LIMESTONE STORAGE
MARSH

Figure 6-2. Potentiometric surface map of the surficial aquifer, Big Bend Station.

6.2 SECONDARY CONSTRUCTION IMPACTS

6.2.1 ATMOSPHERE

There will be no secondary effects on the atmosphere from the construction of the proposed Big Bend Unit 4.

6.2.2 LAND

Secondary construction impacts may include the loss of plants through trampling, spillage, or maintenance activities. However, these impacts would be of short duration, and they would be followed by natural reclamation.

No sensitive wildlife areas will be affected by secondary construction impacts. However, there could be secondary impacts on some wildlife species that occur at the Big Bend site. The increase in traffic due to the expansion of the work force could result in a higher number of animals killed on the road. A reduced speed limit around the site might help reduce highway mortality. The increased influx of people into the area could cause some disturbances to wildlife populations. All remaining natural areas at the site should be protected against littering, off-road vehicle use, hunting, and the harassment of wildlife.

6.2.3 WATER

The construction of the proposed Big Bend Unit 4 will have no secondary effects on surface- or ground-water bodies in the area of the site.

6.2.4 PEOPLE

Secondary construction impacts associated with the construction of Big Bend Unit 4 include induced employment and additional service demands. These secondary demands are discussed in this section.

6.2.4.1 Induced Employment

The employment of approximately 514 construction workers on an average annual daily basis over the 3-year construction period for Unit 4 will have a multiplier effect. It will stimulate the demand for goods and services in those areas where the workers will spend their money, and new jobs will be created to meet this increased demand. The magnitude of this multiplier effect may be limited, however, because of (1) the brevity (3 years) of the construction schedule, which would preclude capital-intensive investment to meet service demands; (2) the brevity (2 months) of the peak construction work period; and (3) the fact that an estimated 90 percent of the construction work force reside in the region and presumably already contribute to the overall regional service demands.

Conservatively assuming that 75 service jobs are created per 100 annual average daily construction employees, it is estimated that 386 service jobs should result.

6.2.4.2 Induced Expansion of Disposable Income

During the construction period, it is estimated that the salaries and wages paid to the construction workers will amount to $11,800,000 (expressed in 1982 dollars). Of this total, an estimated $10,018,200 will constitute disposable income if national patterns prevail (U.S. Department of Commerce 1979). During the construction period, the spending of this income will have a multiplier effect; those receiving the dollars spent by the project workers will respend a portion of their income in the area. As with induced employment, however, the magnitude of this multiplier effect will be tempered by the length of the overall construction schedule and the duration of peak construction. The expansion of disposable income will be of significant economic benefit to the area.

6.2.4.3 Housing and Community Facilities

As with the direct impacts associated with the addition of construction workers for Unit 4, no abnormal stress is expected in terms of housing demand or the need for community facilities and services.

6.2.4.4 Land Use

Although induced employment may place an additional demand on housing and services, the secondary land-use impacts associated with the construction of Unit 4 are not expected to be significant.

6.2.4.5 Transportation

While construction-related traffic demands may produce some intermittent congestion in the site area, neither primary nor secondary construction impacts on transportation are expected to be significant. Projections for the year 2000 (Hillsborough County Board of County Commissioners 1978) call for a minimum highway network with a service level of "D" for normal traffic conditions and a service level of "E" for periods of peak congestion.*

6.2.4.6 Cultural and Historical Sites

The secondary impacts of plant construction on cultural and historical sites are expected to be negligible.

6.2.4.7 Aesthetic Quality

The erection of new structures to service the construction work force will have an indirect aesthetic impact. However, given the brevity of the construction period and the limited size of the work force, that impact is not expected to be significant.

6.2.5 SENSITIVE AREAS

No secondary impacts are expected in the ecologically sensitive mangrove swamp habitat, nor is it expected that any other plant communities will be adversely affected.

No sensitive wildlife areas will be affected by secondary construction impacts.

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*Service level D is a classification applicable to roads with typically "unstable" traffic conditions. On such roads, fluctuations in traffic are conducive to substantial reductions in vehicle speed. Service level E applies to roads on which traffic is typically "very congested." Such a classification prohibits lane changing on multilane roads and passing on two-lane roads.

6.3 PRIMARY OPERATIONS IMPACTS

6.3.1 ATMOSPHERE

6.3.1.1 General Meteorological Effects

The quantitative meteorological effects of powerplant operations cannot be reliably predicted. However, theory and evidence indicate that powerplants of conventional size (up to 4,000 MWe) rarely produce noticeable meteorological changes (temperature, precipitation, or cloudiness), although stack effluents may contribute to air quality problems such as acid rain and reduced visibility on a regional scale (Laurmann 1978; Ramsdell et al. 1977; Cooper and Lukow 1977).

The energy flux and pollution emissions from a single industrial or power facility such as Big Bend Unit 4 are only a fraction of those attributable to a large city, and the corresponding perturbations of rainfall and temperature are much less (Hanna 1978). There are no published studies of temperature perturbations around powerplants and only a few reports of precipitation enhancement have been published. Aerosol emissions from fossil-fired powerplants can act as condensation nuclei (Kellogg 1977) and can, therefore, influence cloudiness and precipitation for many tens of kilometers downwind, but this influence has so far been demonstrated only in special case studies (Hanna 1978). The influence on monthly and annual precipitation patterns has not been satisfactorily determined.

Weather modifications due to individual powerplants are not only usually small, as previously discussed, but they tend to occur only in conjunction with natural meteorological variation such as that accompanying convection (storm) systems. Plant effects, therefore, are not obvious, and they are of minimal significance as contributors to overall change in atmospheric conditions (Laurmann 1978).

6.3.1.2 Dispersion Modeling

The air quality impacts from the operation of the proposed Big Bend Unit 4 were determined by dispersion modeling. The use of dispersion modeling in performing impact analyses, estimating baseline and future air quality levels, and determining compliance with ambient air quality standards (AAQS) and with allowable Prevention of Significant Deterioration (PSD) increments is required by the respective regulations of the U.S. Environmental Protection Agency (EPA; 40 CFR 51, 1978) and the Florida Department of Environmental Regulation (FDER; Florida Administrative Code, Rules of the Florida Department of Environmental Regulation, Section 17-2.05, January 18, 1972, as amended). The assessment was based on the analytical procedures and models contained in the EPA Guideline on Air Quality Models (U.S. Environmental Protection Agency 1978a).

Several widely recognized techniques for estimating or predicting ground-level pollutant concentrations were utilized. The three EPA-approved models used are the Air Quality Display Model (AQDM) with Briggs plume rise, the Point Multiple Model with wind shear effects (PTMTPW), and the CRSTER Single-Source Model (Environmental Science and Engineering, Inc. 1979).

The long-term model AQDM (with Briggs plume rise) requires annual average emissions, stack parameters, and meteorological data in order to calculate annual average concentrations. Annual average emissions and stack parameters for all permitted sulfur dioxide (SO_2) and particulate-matter sources were developed from information in the National Emissions Data System (NEDS) and FDER permit files. The AQDM model was used to estimate annual average ground-level concentrations attributable to all permitted sources and to the Big Bend plant only (incremental impact). Annual average nitrogen dioxide (NO_2) concentrations were estimated for Big Bend alone.

All permitted sources within 50 kilometers of Big Bend, including sources in Hillsborough, Manatee, Pinellas, and Pasco Counties, were utilized in the AQDM emission inventories. A 1-kilometer grid spacing was used in AQDM to estimate the spatial distribution of ground-level concentrations in the vicinity of the site and to determine the maximum annual average concentrations. AQDM-predicted concentrations were not calibrated (i.e., no adjustments were made to model values for either SO_2, total suspended particulates TSP , or NO_2).

The CRSTER short-term dispersion model (U.S. Environmental Protection Agency 1978a) was used to identify worst-case 24- and 3-hour meteorological conditions for SO_2 emissions and worst-case 24-hour conditions for particulate-matter emissions from the proposed plant. Area sources were not considered in the short-term modeling; however, an appropriate short-term TSP background level was added to all point-source concentration estimates to account for area source emissions. This concentration was determined by evaluating the most representative air quality data in the vicinity of Big Bend (Section 6.3.1.7).

Because CRSTER is a single-source model, it is necessary to determine whether other sources in the vicinity of Big Bend will have a significant impact on maximum short-term concentrations. Evaluating the total emissions from each source in the area will ordinarily indicate the major sources that are of concern. All permitted sources within 15 kilometers of Big Bend were included in the short-term modeling evaluation.

Once other critical sources have been determined, the critical meteorological conditions are determined from the CRSTER model results. The major sources are then aligned with Big Bend with respect to wind direction. Using the critical meteorology, maximum concentrations for the area are refined by means of the PTMTPW model. The PTMTPW model allows for much greater flexibility than does CRSTER in that multiple sources and up to 30 receptor distances can be specified. The evaluation of short-term maximum concentrations for future conditions with the proposed unit in operation focuses on the following two factors: (1) the maximum concentration in the area attributable to all permitted sources and (2) the maximum concentration at the point of maximum impact of the proposed new unit together with other Big Bend units.

The short-term concentration estimates provided by the models were not adjusted (i.e., a calibration factor of 1.0 was employed) for either SO_2 or TSP. A minimum receptor grid spacing of 0.1 kilometer was used in PTMTPW to estimate maximum short-term concentrations.

6.3.1.3 Meteorological Data Modeling Input

Both the AQDM and the CRSTER models utilized hourly data records for the period 1971-1975 from the National Weather Service at Tampa International Airport. The AQDM utilized these records in the form of joint frequency distributions of wind direction, wind speed, and atmospheric stability class. These data are provided by the National Climatic Center's STAR program, as are annual averages of temperature, pressure, and maximum afternoon mixing height. They are used to establish a baseline spatial distribution of annual average concentrations and to estimate the spatial distribution of future ambient concentrations. An annual wind rose showing the wind patterns at the site is presented in Figure 6-3. A detailed meteorological discussion is presented in Section 5.1.1.

The CRSTER model processed each hour of the Tampa data set to estimate hourly concentrations over 5 years. These concentrations were then averaged for every 24 and every 3 hours to provide the user with the desired short-term concentrations. The variables input each hour were wind direction, wind speed, dry-bulb temperature, atmospheric stability class, and hourly mixing height. The mixing heights were determined by utilizing radiosonde temperature (lapse rate) data together with hourly surface temperatures. The Tampa International Airport data comprise the most complete and representative meteorological data base available for the Big Bend site. The EPA's wind randomization scheme was utilized in conjunction with the recorded wind direction data in the CRSTER model.

6.3.1.4 PSD Increment Consumption Methodology

Increment consumption was determined by utilizing the results of the AQDM, CRSTER, and PTMTPW dispersion models. Increment consumption due to Big Bend only was determined by modeling baseline and future Big Bend emissions, then subtracting the resulting baseline concentrations from the future concentrations at corresponding grid points. This system yields the spatial distribution of increment consumption for each case evaluated (i.e., annual, 24-hour, SO_2, TSP, etc.), and allows the location and magnitude of maximum increment consumption to be readily identified. The PSD increments are presented in Table 5-8.

For all FDER modeling, baseline concentrations were produced from a 1974 allowable emission inventory of all sources (short-term within 15 kilometers), available in the form of NEDS data from FDER. A future allowable inventory was prepared from the latest available emissions and stack data (generally 1977 NEDS forms). This inventory also included all new sources and modifications that have been permitted since January 1, 1975, as shown by information in FDER permit files.

The following scenarios were first evaluated with respect to Big Bend only in the SO_2 short-term model:

1. All Big Bend units at 100 percent load
2. All Big Bend units at 75 percent load
3. All Big Bend units at 50 percent load
4. Big Bend Units 1, 2, and 4 only at 100 percent load (critical load found in cases 1, 2, or 3 above)
5. Big Bend Units 1 and 4 only at 100 percent load (critical load found in cases 1, 2, or 3 above)

The emissions and operating parameters of existing and proposed Big Bend units used in these scenarios are presented in Table 6-3. Since the results of the SO_2 modeling showed that maximum impacts would result from 100 percent load conditions, only the three 100 percent cases were utilized for the TSP evaluation. Presented in Table 6-4 is the FDER PSD maximum increment consumption at the Big Bend site.

The EPA baseline and projected annual runs included only those sources that have been permitted or modified since January 6, 1975. With Big Bend Unit 4, the total increments at the site are determined directly from the models by comparing baseline and projected concentrations for corresponding grid points. Short-term interaction cases were executed in the same fashion, with all new and modified sources within 15 kilometers included in the analyses. A close inspection of the Big Bend emission history shows that the short-term baseline emission conditions calculated in accordance with EPA and FDER criteria are equivalent.

To produce isopleths for the site map, the CRSTER Single-Source Model was executed twice, and receptors at 0.5 to 2.5 and 3 to 5 kilometers at a 0.5-kilometer spacing were postulated. The CRSTER model has a modified output that can process 5 years of meteorological data in a single program execution. Highest and highest second-highest summary tables for each year and a maximum composite table for all 5 years are printed. The composite tables can be used to determine the maximum highest second-highest 3-hour concentration at any receptor for a 5-year period. In addition to printed output, each composite table can be written directly onto a disk data set. For SO_2 site runs, both the 24- and 3-hour highest second-highest composite tables are put directly onto disk. For particulate matter, only the 24-hour highest second-highest tables are put onto disk.

As described previously, five plant operating conditions were evaluated for each averaging time. For each operating condition executed, a composite table is put onto disk. Each disk is then compared receptor point by receptor point with the other four disks. The maximum value at each point (i.e., the highest of the five values compared) goes onto a maximum composite disk for the averaging time and the pollutant.

A maximum composite increment disk is developed by subtracting values on a maximum composite baseline disk from those on a maximum composite projected disk. This is accomplished for each pollutant and averaging time. A listing of all maximum composite tables is included in Appendix E of the PSD Application (Environmental Science and Engineering, Inc. 1979).

All the projected composites are handled in the same fashion. The maximum PSD increment is then determined spatially at the site. Once a composite baseline disk and a projected emission disk file are created, a computer program is used to subtract grid point values of the former from corresponding grid point values of the latter to obtain a spatial distribution of all short-term increments. The short-term maximum and annual maximum increments are the largest concentration differences between baseline and future runs. These maximum increments do not necessarily correspond to the maximum concentrations in either the baseline or the projected runs.

The SYMAP computerized interpolating routine was used to depict the spatial distribution of concentrations on all base maps for both AQDM and CRSTER results.

6.3.1.5 AAQS Impact Determination Methodology

6.3.1.5.1 Attainment Areas

Attainment areas include all those areas outside of the two nonattainment areas mentioned earlier in this report. Compliance with all AAQS was determined in the vicinity of the Big Bend site. Maximum annual average concentrations were determined from AQDM for all sources within a 50-kilometer radius at maximum allowable emissions. This included all permitted sources of SO_2 and particulate matter within Pinellas, Hillsborough, Pasco, and Manatee Counties. As with the increment maps, isopleth maps were made from the model output so that the ambient air quality could be depicted spatially. The maximum annual value was determined from a 1.0-kilometer grid spacing. Federal and Florida AAQS are presented in Table 5-6.

Both 24- and 3-hour maximum concentrations were determined in the vicinity of the site by the "worst-day" methodology. This involved determining which day in 5 years gives the highest second-highest concentration with the proposed unit operating at the Big Bend site. These days were determined for both SO_2 and particulate matter, and the maximum value was further refined by means of the PTMTPW model. The CRSTER runs utilized a grid resolution of 0.5 kilometer, and PTMTPW was used to refine the grid spacing to 0.1 kilometer.

For SO_2, the 3-hour highest second-highest value was obtained from CRSTER, and the period of this concentration was then determined. If necessary, adjacent hours were combined and/or dropped to maximize concentrations. The worst hour of the 3-hour period was then aligned with the source and receptors to get the maximum possible concentration.

Both incremental and interaction maximums were determined for the short-term effort. Interaction runs included winds directed toward TECO Big Bend from the Florida Power & Light Company's Manatee plant, TECO Hookers Point, TECO Gannon, and Gardinier. All emissions were at maximum allowable rates for both SO_2 and particulate matter.

6.3.1.5.2 Nonattainment Areas

The EPA's official Emissions Offset Interpretative Ruling (40 CFR 51, Appendix S, 1979) set forth specific requirements pertaining to new sources locating in or near designated nonattainment areas. However, this policy expired on July 1, 1979, with the requirement that approved State Implementation Plans regarding nonattainment areas be approved by the EPA as of this date or all new-source construction in these areas would be halted pending such approval.

Because nonattainment rules are currently in a state of flux, the nonattainment evaluation for Big Bend Unit 4 was conducted utilizing the policies set forth in the EPA Interpretative Ruling. This policy applies only if certain "significance of impact levels" are exceeded by the proposed plant in the area of nonattainment (Table 5-7). Therefore, the modeling study was conducted to evaluate the impact of Big Bend Unit 4 on the nearby designated nonattainment areas for SO_2 and suspended particulate matter.

The annual average impact of the proposed unit was determined by adding additional receptors into the AQDM model for the borders of the nonattainment areas. Similarly, for the short-term impact, the CRSTER model was executed to find key receptors on the borders of the nonattainment areas. Because the Pinellas County nonattainment area is 53 kilometers from the site, the maximum impact will be at the edge of the area nearest to the site. The closest receptor is at the southeast corner (defined by Universal Transverse Mercator coordinates 329.0 E and 3117.0 N). For the Hillsborough County nonattainment area, the worst-case receptor is 5.5 kilometers due north of Big Bend.

6.3.1.6 Background TSP Estimation

Only stationary point sources of particulate matter are accounted for in the emission inventories used in the atmospheric dispersion models. However, many sources of fugitive particulate matter exist in the Tampa-Big Bend area, and there is a natural background TSP level. To account for these fugitive emissions and the natural dust level, a background TSP concentration is added to the modeling results for both the long-term and the short-term averaging time.

For the annual averaging time, a background TSP level was obtained by averaging the geometric mean TSP concentrations presented in Table 5-16. This results in an average concentration of 35.9 µg/m^3. For convenience, and since this average level reflects point-source contributions from particulate matter emitters in the TECO Big Bend area, an annual background TSP level of 35 µg/m^3 was used in this study. This value was added to all annual average model results to obtain total air quality level predictions.

A statistical approach was utilized to determine an appropriate short-term (24-hour) background TSP level. It is not justifiable to utilize the highest or second-highest measured values at the monitoring stations, since it is highly unlikely that worst-case meteorological conditions for point-source emissions will occur in conjunction with a worst-case background level. A statistically more valid level, used in previous modeling studies in Florida, is a level that is exceeded 16 percent of the time, or the 84th percentile concentration. The probability of occurrence of this background level and worst-case point-source model predictions is less than 1 day in 5 years.

Analysis of many years of ambient TSP data has shown that such data tend to be log-normally distributed. If the log-normal distribution is assumed, the method of Larsen (1971) can be utilized to estimate the 84th percentile concentration from the annual average concentration. The equation for the conversion is the following:

$$C = M\ Sg^{z-0.5\ \ln Sg} \qquad (6\text{-}1)$$

where

C = 84th percentile concentration
M = arithmetic mean
Sg = geometric standard deviation
z = 1.0, number of standard deviations from mean for 84th percentile

The range of Sg values for the sampling data presented (excluding data not representative of an entire year) is from 1.35 to 1.96. Substituting the highest of these values into the above equation yields the following:

$$C = M(1.56) \qquad (6\text{-}2)$$

Thus, the 84th percentile concentration is equivalent to 1.56 times the arithmetic mean. Applying this factor to the 35.9-µg/m^3 annual average background yields a 24-hour TSP background concentration of approximately 55 µg/m^3. This is extremely conservative since the average Sg value is 1.48.

6.3.1.7 Determination of Federal PSD Baseline

"Baseline concentration" is defined by the EPA (40 CFR 51, 1978) as follows:

> . . . that ambient concentration level reflecting actual air quality as of August 7, 1977, minus any contribution from major stationary sources and major modifications on which construction commenced on or after January 6, 1975. The baseline concentration shall include contributions from: . . . (ii) the allowable emissions of major stationary sources and major modifications which commenced construction before January 6, 1975, but were not in operation by August 7, 1977.

In applying the baseline emissions concept, the EPA does not require the establishment of a formal baseline concentration. Essentially, only those sources that have changed emission rates and/or stack parameters or new sources that have commenced construction since the baseline date need to be evaluated. In essence, these sources would either expand or consume PSD increments. Other sources would not affect PSD increment consumption. "This policy is consistent with the intent of the Act to base increment consumption on all emission increases from new and modified sources, but to allow consumption of the increment to occur from only certain nonmodification activities (e.g., some fuel switches) of existing sources" (40 CFR 51, 1978).

In considering factors such as hours of operation, capacity utilization, and types of materials combusted, processed, and/or stored, "1977 values will generally be used"; however, the baseline emissions concept "also includes . . . any future increases in hours of operation or capacity utilization as they occur if such are allowed to the source as of August 7, 1977, and if the source could have been reasonably expected to make these increases on this date" (40 CFR 51, 1978).

The baseline SO_2 emission rates utilized in the PSD evaluation of total emissions from Big Bend Units 1, 2, and 3 were the allowable emission rates of 32 tons/hr, the maximum 24-hour emission capacity, and 35 tons/hr, the maximum 3-hour emission capacity. This emission limitation was in effect at Big Bend until October 1, 1977, and therefore reflects emissions as of August 7, 1977. Short-term 24- and 3-hour particulate-matter emission rates were based on the allowable emission limit of 0.1 lb/10^6 Btu heat input.

The annual baseline emissions for Big Bend reflect the actual capacity utilization that occurred at the plant in 1977: 67 percent for Unit 1, 64 percent for Unit 2, and 61 percent for Unit 3. The short-term baseline levels were developed by considering

Big Bend Units 1, 2, and 3 operating at 100, 75, and 50 percent load, and Units 1 and 3 operating only at 100 percent load.

The baseline concentrations were then determined by identifying the maximum highest second-highest SO_2 concentration at each receptor point for all operating conditions evaluated.

A number of sources in Hillsborough, Pinellas, Pasco, and Manatee Counties were identified as being modified after January 6, 1975. A list of new and modified sources commencing construction after January 1, 1975, is presented in Appendix G of the PSD Application (Environmental Science and Engineering, Inc. 1979). These sources consume or expand PSD increments, depending on the particular modification conditions. To establish the EPA annual baseline levels, these modified sources were modeled in accordance with their premodification stack and emission parameters. The estimated air quality levels were subtracted from predicted levels (for corresponding receptor points) based on the operation of all new and modified sources at maximum allowable emission rates. The modified source data reflected postmodification conditions. This methodology determined annual EPA increment consumption.

Figures 6-4 and 6-5 show the results of the EPA baseline annual modeling for SO_2 and TSP, respectively.

The 24- and 3-hour SO_2 baseline estimates are shown in Figures 6-6 and 6-7, respectively. Similarly, Figure 6-8 shows the 24-hour TSP baseline concentrations. These baseline concentrations, as described previously, represent maximum highest second-highest concentrations for a number of representative operating conditions. They are reflective of emissions from Big Bend only.

6.3.1.8 Determination of State of Florida PSD Baseline

The State of Florida (Florida Administrative Code, Rules of the Florida Department of Environmental Regulations, Section 17-2.05, January 18, 1972, as amended) has defined baseline concentrations of SO_2 and particulate matter for PSD purposes as follows:

> . . . the applicable ambient concentration levels existing during 1974 plus any additional concentrations for the area of impact estimated to result from sources permitted for construction but not operating prior to January 1, 1975.

In October 1978, the FDER Bureau of Air Quality Management published "Guidelines on Prevention of Significant Deterioration (PSD) - PSD Review." The following statement appears in this document: "Baseline emissions data consist of the January 1, 1975 allowable emission rates and January 1, 1975 stack configurations for all sources holding either an operating or construction permit during any part of 1974."

To comply with these requirements, a 1974 allowable emission inventory reflecting January 1, 1975, conditions was developed for SO_2 and particulate matter, based on available FDER information. For Big Bend, the allowable emissions for 1974 were a total of 32 tons/hr from all three units for SO_2 (24-hour average) and 0.1 lb/10^6 Btu for particulate matter. These allowable rates include the emissions from Big Bend Unit 3, which had received a permit for construction but was not operating as of January 1, 1975.

For the annual averaging time, all sources in Pasco, Pinellas, Hillsborough, and Manatee Counties were included in the inventory. The AQDM output is presented in Appendix B of PSD Application (Environmental Science and Engineering, Inc. 1979). Shown in Figure 6-9 are FDER annual average baseline SO_2 concentrations in the vicinity of Big Bend. Similarly, shown in Figure 6-10 are FDER annual average baseline TSP concentrations. Background TSP levels have not been included in the baseline estimates, since background does not affect increment consumption. The short-term baseline SO_2 and particulate-matter concentrations reflect the emissions attributable to Big Bend only. Because other sources are not located within 5 kilometers of Big Bend, such sources would only contribute slightly to baseline concentrations and only for certain wind directions. Big Bend has a major impact on short-term levels within this distance. Big Bend baseline emissions are based on the allowable

SO_2 emissions from all three units of 32 and 35 tons/hr for the 24- and 3-hour averaging times, respectively. The emission baseline is presented in Appendix F of the PSD Application (Environmental Science and Engineering, Inc. 1979). Short-term particulate-matter emissions were based on 0.1 lb/10^6 Btu heat input.

To establish short-term baseline levels, several representative operating conditions were evaluated, including 100, 75, and 50 percent load for all three units and 100 percent load for Units 1 and 3 only. Since Units 1 and 2 utilize the same stack, the operation of only one of these units significantly decreased the stack-gas exit velocity.

The short-term baseline concentrations (Figures 6-6 through 6-8) were developed for the EPA and are also applicable to the FDER analysis. These concentrations represent the highest second-highest concentrations for each receptor predicted by the CRSTER model for any of the operating conditions evaluated.

6.3.1.9 PSD Increment Consumption

With respect to the classification of PSD areas, the EPA has designated all airspace within 90 kilometers of Big Bend as Class II. The Class I area nearest Big Bend is the extreme southeastern edge of the Chassahowitzka Wilderness Area, which is approximately 92 kilometers from the site.

In this section, the PSD Class II increment consumption is shown for each applicable averaging time and pollutant. All significant interacting sources are included in the analysis.

6.3.1.9.1 FDER Annual Increment Consumption

Figures 6-11 and 6-12 portray the spatial annual increment consumption according to the FDER definitions of baseline and projected emissions for SO_2 and TSP, respectively. The spatial SO_2 increment consumption in the vicinity of Big Bend indicates uniform air quality improvement with respect to SO_2 since 1974, the baseline year. For TSP, the only positive increment consumption on the map is traceable to a small source that had a 1974 allowable emission rate of 133 tons/yr for particulate matter.

The Agrico Chemical Company (Hillsborough County, NEDS No. 94-01), located 1.3 kilometers north-northwest of Big Bend, has actual annual particulate emissions of 5 tons as a result of using baghouses with 99 percent control efficiency. The allowable particulate emissions are 27 times greater than the actual emissions of this source, so that only a "modeling" violation of PSD increments is predicted to occur. The maximum particulate-matter increment consumption (24.0 μg/m^3) occurred at a receptor 200 meters south of Agrico. The contribution of Big Bend (with all four units at full load) to the increment consumption at that receptor was 0.0 μg/m^3. Agrico's impact at allowable emissions is 25.4 μg/m^3. Therefore, at actual emissions, its annual impact would be less than 1 μg/m^3, and the total increment consumption at this receptor would be approximately -0.2 μg/m^3, or a slight net improvement in air quality.

6.3.1.9.2 FDER Short-Term Increment Consumption

Figures 6-13 and 6-14 show the spatial 24-hour SO_2 and TSP increment consumption attributable to Big Bend only. Short-term maximum source interaction increments are shown in tabular form only in Table 6-4. Beyond 0.5 kilometer from Big Bend, the air quality shows some improvement in terms of 24-hour SO_2 concentrations and only a slight deterioration in terms of the 24-hour levels of particulate matter (0.3 μg/m^3) at a few receptors. From 0 to 0.5 kilometer, increment consumption is 0.0 for both pollutants, owing to the proximity to the Big Bend stacks.

The 3-hour SO_2 PSD increment consumption is shown in Figure 6-15. As indicated in the figure, there is only a very small area in which positive increment consumption occurs. The magnitude of this consumption (67.7 μg/m^3) is still nearly a factor of 8 below the allowable PSD increment of 512 μg/m^3.

Since it is the major source at the site, the Big Bend Station will dominate source interactions and will determine worst-case meteorological conditions for these interactions. Data on Big Bend as the only source show lower than baseline SO_2 concentrations at every point on the site for the 24-hour case and only a small, isolated occurrence of higher than baseline concentrations for the 3-hour case. Short-term source interaction data reveal, furthermore, that the largest SO_2 PSD increment consumption at the site is attributable solely to Big Bend, since the critical meteorology does not align Big Bend with other increment-consuming sources. Taken together, these findings suggest that air quality as defined by SO_2 levels should be comparatively high in the site region on all but the worst days for Big Bend operation.

To determine the maximum 24-hour TSP increment consumption, Big Bend was aligned with major TSP sources in the area (e.g., Agrico). Worst-case interaction was with Agrico by way of winds directed from Agrico toward Big Bend. This interaction resulted in a maximum TSP increment consumption of 3.7 μg/m^3, to which Big Bend contributed 0.0 μg/m^3.

6.3.1.9.3 EPA Annual Increment Consumption

The annual SO_2 and TSP spatial increment consumptions at Big Bend are shown in Figures 6-16 and 6-17. Figure 6-16 shows low SO_2 concentrations in the air at all site receptors. Figure 6-17 shows generally slight TSP increment consumption except for a small area surrounding the Agrico Chemical facility. The maximum increment consumption is 26.6 μg/m^3, and this occurs as a result of the modeling of Agrico at its allowable emission rates, as discussed in Section 6.3.1.9.1. If Agrico were modeled its actual emissions, TSP increment consumption would be on the order of 2 μg/m^3.

6.3.1.9.4 EPA Short-Term Increment Consumption

The short-term increment consumption analysis was performed in accordance with the FDER rules and guidelines, since the EPA baseline emissions were also determined to be the allowable rates for Big Bend. On August 7, 1977, the EPA baseline date, the allowable emissions were 35 tons/hr as the 3-hour capacity and 32 tons/hr as the 24-hour capacity for all units (Environmental Science and Engineering, Inc. 1979). These emission rates are consistent with the 1974 FDER baseline. The visual displays of short-term increment consumption for EPA are identical with those for the FDER and are presented in Figures 6-13 through 6-15. A summary of all Class II PSD results for the EPA is included in Table 6-5.

6.3.1.9.5 Class I Impacts

The Class I area nearest to Big Bend is the Chassahowitzka Wilderness area, located 92 kilometers to the north. The impacts of the proposed Big Bend Unit 4 on the Pinellas County nonattainment area, located 52 kilometers to the northeast, are presented in Table 6-6 and discussed in Section 6.3.1.10. The predicted SO_2 impacts are below the significance of impacts levels, which for SO_2 short-term averaging times are identical with the Class I PSD increments. Therefore, it is expected that such impacts at a distance of 92 kilometers will be much less than the allowable Class I increments.

6.3.1.10 Compliance With AAQS

6.3.1.10.1 Compliance With Annual AAQS

The EPA and FDER analysis to determine compliance with SO_2 and TSP AAQS was based on all sources within approximately 50- kilometers, including all sources in Pinellas, Manatee, Pasco, and Hillsborough Counties. Maximum allowable emission rates were used for all sources. Figures 6-18 and 6-19 portray the projected annual SO_2 and TSP concentrations, respectively, at the Big Bend site for all interacting sources. The TSP values shown include the annual average background level of 35 $\mu g/m^3$ (Section 6.3.1.6).

The maximum annual SO_2 concentration is 18.5 $\mu g/m^3$, and this occurs toward downtown Tampa (northwest corner of the site map, Figure 6-18). The State of Florida SO_2 annual AAQS is 60 $\mu g/m^3$. The effect on the site of Agrico Chemical's allowable TSP emission rate is to create an isolated TSP maximum of 69.2 $\mu g/m^3$, with a background of 35 $\mu g/m^3$, and to create an annual violation of AAQS at this point. The Big Bend plant (all four units operating) contributes 0.0 $\mu g/m^3$ to TSP concentrations at that particular receptor.

The maximum annual nitrogen dioxide (NO_2) concentration from the operation of Big Bend Unit 4 is 0.5 $\mu g/m^3$. This concentration is well below the level of significant impact on ambient air quality, and hence a more detailed analysis is not required (40 CFR 52). The maximum impact, level of significant impact, and AAQS are shown in Table 6-7.

6.3.1.10.2 Short-Term Compliance With AAQS

The projected site area 24-hour SO_2 concentrations attributable solely to the Big Bend facility with Units 1, 2, and 4 operating at 100 percent load are shown in Figure 6-20. The maximum 24-hour concentration is 145 μg/m3. (Occasional slight discrepancies between the short-term concentrations presented in the text and those presented on the SYMAP figures reflect the refinement due to the PTMTPW model.) The 24-hour AAQS is 260 $\mu g/m^3$. The maximum 24-hour interaction concentration, considering all sources in the vicinity of Big Bend, is 82 $\mu g/m^3$. This maximum interaction occurred with winds directed from the Manatee plant of the Florida Power & Light Company (FP&L). The addition of all other sources near Big Bend does not fully compensate for the loss of Big Bend's critical worst-case meteorology and the use of a 50 percent load factor for the Big Bend Station.

The 24-hour TSP concentrations caused by Big Bend alone are shown spatially in Figure 6-21. The maximum TSP concentration is 3.7 $\mu g/m^3$, which is below the significance of impact level of 5 $\mu g/m^3$. Since the purpose of this report was not to analyze the air quality impact of the nearby Agrico facility, the maximum short-term impacts of Agrico with Big Bend contributing were not determined. However, Big Bend's contribution to the Agrico site is less than 1.0 $\mu g/m^3$ as a 24-hour maximum. Source interactions were determined for TSP carried by winds directed toward Big Bend from FP&L Manatee, Agrico, and other major particulate-matter sources. The resulting maximum was 128.1 μg/m^3 for winds directed from FP&L Manatee. This value includes the 55-μg/m^3 background concentration (Section 6.3.1.6). Big Bend contributes 0.0 μg/m^3 to this concentration, while Agrico's contribution is 72 μg/m^3.

The 3-hour SO_2 concentrations attributable to the Big Bend facility are shown in Figure 6-22. The maximum concentration is 1,086.5 μg/m^3, which is below the 3-hour SO_2 AAQS of 1,300 μg/m^3. The maximum 3-hour interaction concentration is 992 μg/m^3, and this reflects the interaction of FP&L Manatee and TECO Big Bend. Again, the addition of all sources near Big Bend does not fully compensate for the loss of Big Bend's worst 3-hour meteorology and a 50 percent load factor for the Big Bend facility. All projected ambient air quality impacts, demonstrating Big Bend's compliance with TSP and SO_2 AAQS, are presented in Table 6-6.

The maximum short-term carbon monoxide (CO) impacts from the operation of Big Bend Unit 4 were established by using maximum 3-hour SO_2 impacts. (It should be noted that AAQS averaging of CO concentrations is performed only at 1- and 8-hour intervals.) The maximum 3-hour CO concentration is 7.8 μg/m^3. Since this concentration is well below the level of significant impact on ambient air quality, a more detailed analysis is not required (40 CFR 52). The maximum impact, level at significant impact, and AAQS are shown in Table 6-7.

6.3.1.11 Maximum Incremental Impact and Nonattainment Area Impact

Figures 6-23 and 6-24 present the annual average concentrations of SO_2 and TSP, respectively, resulting from the operation of Big Bend Unit 4 without Unit 3 (worst-case condition, since the exit velocity is significantly decreased). The maximum annual SO_2 concentration is 1.0 μg/m^3, whereas the maximum TSP concentration is much less than 1 μg/m^3.

A short-term analysis of Unit 4 only is presented in Figures 6-25 through 1-27. Figure 6-25 shows the maximum 24-hour SO_2 concentrations resulting from the operation of Unit 4 without Unit 3. This maximum concentration is 34.2 μg/m^3. The maximum 24-hour impact on the Pinellas County SO_2 nonattainment area is 4.0 μg/m^3, which is below the 5-μg/m^3 significance level required for emission offsets to be applicable. The 3-hour SO_2 impact of Unit 4 only is provided in Figure 6-27. The maximum concentration is 163 μg/m^3. The SO_2 impact of this source on the Pinellas County nonattainment area is 17.0 μg/m^3, which is below the significance level of 25 μg/m^3. The maximum 24-hour TSP concentration (Figure 6-26) is 0.9 μg/m^3. The Big Bend source, therefore, does not significantly impact TSP levels at the Hillsborough County TSP nonattainment area, which is 5.3 kilometers north of the plant.

Incremental Unit 4 impacts, both at points of maximum impact and at nonattainment area boundaries, are summarized in Table 6-6.

6.3.1.12 Worst-Case Meteorology

Table 6-8 identifies the worst 24- and 3-hour periods that resulted from the execution of the CRSTER model. A printout of the meteorological data cited in this table is included in Appendix H of the PSD Application (Environmental Science and Engineering, Inc. 1979). The PTMTPW model was used in conjunction with these worst days both to refine the CRSTER results and to provide maximum interaction-caused concentrations and PSD increment consumption in the vicinity of Big Bend.

The following PTMTPW runs were executed for the purpose of resolving CRSTER results:

- Maximum impact of Big Bend Unit 4 only (24-hour SO_2 and TSP and 3-hour SO_2 concentrations)
- Maximum 3-hour SO_2 impact of Big Bend Unit 4 only on the Pinellas County nonattainment area
- Maximum impact of Big Bend Units 1-4 (24-hour SO_2 and TSP and 3-hour SO_2 concentrations)

The following PTMTPW runs were executed for the purpose of determining interaction-caused maximum concentrations and PSD increment consumption:

- Maximum 24-hour SO_2 and TSP and 3-hour SO_2 PSD Class II increment consumption by Big Bend Units 1-4, with all units interacting
- Maximum air quality impact of interacting sources (24-hour SO_2 and TSP and 3-hour SO_2).

6.3.1.13 Additional Impacts

Federal PSD regulations require "additional impact analyses," including "an analysis of the impairment to visibility, soils, and vegetation that would occur as a result of the source or modification." In the preamble to these regulations, further guidance is provided relative to the required analysis: "The analysis related to a source's impact on soils, vegetation and visibility should focus primarily on such impacts in Class I areas . . . ," and "The impact assessment should generally be qualitative in nature and designed to inform the general public of the relative impact of the source on those values."

Since the AAQS and the allowable Class I and Class II PSD increments are not predicted to be exceeded by the operation of the proposed unit, the impacts of operation on soils and vegetation are not expected to be significant. Federal primary AAQS were promulgated in order to protect the public health, and secondary AAQS were promulgated in order to protect the public welfare (i.e., damage to vegetation, animals, soils, visibility, structures, etc.), both with an adequate margin of safety. As part of the Florida Sulfur Oxides Study (Environmental Research and Technology, Inc. 1978), a study was conducted in Florida of the environmental effects of ambient SO_2. The study concluded that "there is not reasonable basis in the established body of scientific information for assuming that existing Federal ambient air quality legislation is not sufficiently stringent to protect Florida's environment from significant stress caused by sulfur oxides." It is noted that while the EPA has rescinded its 24-hour and annual secondary AAQS, the State of Florida has retained these standards, providing an additional margin of safety beyond that already inherent in the Federal standards.

Recently promulgated Federal new-source performance standards (NSPS) for fossil-fuel-fired steam generators limit the opacity of emissions from the proposed Big Bend Unit 4 to 20 percent, except for one 6-min/hr period, when emissions are restricted to not more than 27 percent opacity (44 FR 113, June 11, 1979). These opacity limits, coupled with the stringent NSPS requirements on SO_2 and particulate-matter emissions, will insure that impacts on, and impairments to, visibility will be minimal. The nearest Class I PSD area is 92 kilometers from Big Bend, and therefore no significant visibility impacts on such areas are expected to result from the operation of the proposed Big Bend Unit 4.

The waste-handling system to be employed at Big Bend Unit 4 for the by-product of flue-gas desulfurization (FSD) is designed to dewater the by-product gypsum to 90 percent solids. The Applicant has stated that, during startup, shutdown, and malfunctions, the system will dewater the gypsum to at least 80 percent solids (Tampa Electric Company 1980a). In either case, the moisture content should ensure that the gypsum will not cause a fugitive-dust problem during transportation.

6.3.1.14 Cooling-Tower Impacts

Potential impacts to the atmosphere that could result from the operation of a mechanical-draft cooling tower at Big Bend, should this alternative waste-heat rejection system be employed, include the effects of salt drift and ground-level fogging.

6.3.1.14.1 Salt Drift and Air Quality Regulations

Stone & Webster Engineering Corporation (1979) evaluated cooling-tower salt drift as related to emission limitations, air-quality standards, and PSD and emission-offset regulations for airborne particulates. The evaluation was based on Florida limits on particulate emission from various processes, as expressed in the following formula:

$$\text{Allowable emissions (pounds per hour)} = 17.31P^{0.16} \qquad (6\text{-}3)$$

where P is the process flow (e.g., circulating-water flow) in tons per hour.

Given a circulating-water flow of 250,000 gpm, the allowable emissions calculated by this formula would be about 100 lb/hr. The total drift emission, using a drift rate of 0.002 percent and a circulating-water salinity of 42 ppt, would be about 105 lb/hr. Thus, if an emission limitation were applied to the cooling tower, based on the formula given above, the total drift emissions from the tower would have to be reduced by approximately 5 percent.

To give an indication of the contribution of cooling-tower drift to particulate concentrations, Table 6-9 was prepared. This table, which was developed from data presented in Table 6-10, shows the annual average and maximum 24-hour particulate concentrations in the worst sector for the mechanical-draft tower; it is based on the results of the Stone & Webster Salt Drift Model (Stone & Webster Engineering Corporation 1979), which is discussed in Section 6.3.2.2. Two values are given, one for suspended particulates and one for total airborne particulates. Suspended particulates were defined as those smaller than 50 micrometers. Also shown in the table are the allowable Class II PSD increments. A second Applicant-sponsored modeling study was conducted (Environmental Science and Engineering, Inc. 1980) using the Oak Ridge Fog and Drift Model (LaVerne 1977). Data from that study included predictions of maximum annual average concentrations of airborne salt resulting from a mechanical-draft cooling tower at Big Bend. These data are presented in Table 6-11 for comparison.

For annual airborne salt concentration, the ORFAD model predicted a maximum of 1.49 $\mu g/m^3$ for the mechanical-draft cooling tower, while the S&W model predicted 5.88 $\mu g/m^3$, or roughly 4 times the ORFAD results. The positions of the maxima were approximately the same with both models; the ORFAD maximum was 800 to 1,100 feet west of the tower, and S&W's was 500 to 750 feet northwest of the tower.

Salt drift predicted by the ORFAD model was 83.4 $g/(m^2)(yr)$ while the S&W model predicted 142, or about 1.7 times the ORFAD results. The positions of the maxima were the same as for the maximum annual airborne salt concentrations. Since identical input data were used by both models, the different results are attributed to differences in model formulation (Environmental Science and Engineering, Inc. 1981). Both models are in general agreement as to the locations of maxima, with the S&W model predicting higher maximum concentrations.

Table 6-9 shows that the definition of a suspended particle is critical; it can affect the calculated concentrations by one or two orders of magnitude, based on the assumptions used in developing the data in the table. It also shows that the cooling-tower drift can make a substantial contribution to the PSD increment consumption of total suspended particulates, the magnitude of the concentration depending on the definition of suspended particles.

6.3.1.14.2 Ground-Level Fogging*

The extent to which a mechanical-draft cooling tower would induce ground-level fogging was assessed using a mathematical model that predicts the configuration and frequency of occurrence of visible plumes resulting from the operation of the cooling tower. Unlike natural-draft towers, which discharge the visible plume at an elevation that precludes plume downwashing, mechanical-draft towers discharge at approximately 70 feet above ground level. Therefore, the effects of aerodynamic downwash on ground-level fogging potential must also be evaluated. The results of the visible-plume analysis for mechanical-draft tower, presented in Figure 6-28, suggest that the potential occurrence of ground fog will be infrequent and generaly confined to the immediate site area. Icing resulting from ground fogging is expected to be rare because of the generally mild climate in the area of the site.

6.3.1.15 Noise

6.3.1.15.1 Powerplant Operation

Estimates of the noise from the operation of Unit 4 are discussed in Section 4.2.11. All the sound levels due to the operation of Units 1 through 4 are expected to meet or be below the maximum daytime (60 dBA) and nighttime (55 dBA) residential sound levels permissible under the Hillsborough County noise code (1976). In addition, the estimated contributions of the plant to the continuous noise levels are less than the average nighttime residual sound levels at Locations 4, 5, and 8 (Figure 5-9). (A "residual" sound level is one that equals or exceeds the sound level occurring in an area 90 percent of the time.) The estimated operational sound levels are also only 4 and 2 dBA greater than the nighttime residual ambient levels at Locations 6 and 7, respectively. The nighttime intermittent sound levels are expected to range from 3 to 10 dBA higher than the residual nighttime levels, and the daytime intermittent sound levels are expected to be as much as 17 dBA higher than the residual daytime levels. However, similar variations in ambient sound levels presently occur because of variations in existing ambient noise sources (Section 5.1.3). Therefore, no significant noise impact is expected at the surrounding residences from the operation of Unit 4.

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*Stone & Webster Engineering Corporation (1979).

6.3.1.15.2 Cooling-Tower Operation*

Estimates were made of the sound levels expected for a mechanical-draft cooling tower alone and for the total levels of the tower and other plant sources. The sound levels were predicted for Newman Branch Road (Location 6; Figure 5-9), the nearest residential area to the site. Sound levels were estimated for the mechanical-draft cooling tower using the technique of Dyer and Miller (1959). The sound levels from the other major sources of noise from Unit 4, including the fans, boiler, turbine building, and transformers, were predicted from data gathered for the site certification application. In predicting the sound levels, it was assumed that only excess attenuation resulting from atmospheric absorption at standard conditions would attenuate noise from the station.

The sound level expected on Newman Branch Road from a mechanical-draft cooling tower is 53 dBA. Operating alone, this type of cooling tower would conform to the Hillsborough County noise code requirements.

In addition, the cooling-tower noise was evaluated in terms of its potential contribution to the overall plant noise from the Big Bend Station. Even without a cooling tower for Big Bend Unit 4, noise control of the unit's induced-draft fans (and possibly the forced-draft fans) will be necessary to meet the noise criteria. It is expected that the fan noise control requirements would be approximately the same for the unit operating alone or the unit operating with the mechanical-draft cooling tower. With noise control provided for the unit, the total property-line sound levels from Big Bend Unit 4 with a mechanical-draft cooling tower will be 1 or 2 dBA higher than for the cooling tower alone. Thus, the property-line noise criteria will still be met.

6.3.2 LAND

6.3.2.1 Powerplant Operation

During the operating phase, lands in transmission line corridors, laydown areas, and grounds adjacent to new structures associated with Unit 4 will be subject to increased traffic. In the absence of revegetation programs, seasonal impacts of surface soils may occur; accordingly, more dust should be expected during the dry season and more water erosion during wet periods. The postconstruction condition of these lands is expected to be superior to the present condition by virtue of corrective actions that can be taken during the construction phase. The overall benefits of a revegetation program should be substantial. It is expected that efforts at revegetation will be limited to grass or low ornamentals that do not require extensive maintenance or interfere with plant operations.

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*Stone & Webster Engineering Corporation (1979).

Because the coal fuel will be received, stored, and handled in the same manner and with the same facilities as are now used for Units 1, 2, and 3, no adverse impacts on the terrestrial ecosystem are expected. Impacts due to dust and noise may occur, but these will be minor and will not affect important wildlife or their habitats. Runoff from the coal-storage pile will be controlled by retention trenches, and contamination of adjacent soils is not expected.

The primary impact on terrestrial systems from the operation of the sulfur dioxide control system will be the preemption of approximately 97 acres of land for the FGD by-product storage/disposal area (Section 6.1.2). Depending on the marketability of the by-product gypsum, onsite storage/disposal will either temporarily or permanently remove the areas from further use for the lifetime of the plant.

The disposal plan calls for the staged development of four separate storage/disposal areas. A new area will be developed as needed when the area in service nears its storage capacity. Such an arrangement provides for both short- and long-term storage, and for permanent disposal if necessary. If the gypsum cannot be sold, the use of small disposal areas allows for better control of rainfall runoff and housekeeping procedures.

Soils at this site belong to the Sunniland-Bradenton association, which is characterized by poorly drained soils with thin, sandy layers over loamy subsoil underlain by marly material (Florida Department of Administration 1975; Stone & Webster Engineering Corporation 1973). Permeabilities range from 0.05 to 0.0001 centimeter per second for the first 15 feet of soils.

The by-product gypsum will be transported to the proposed site by means of a conveyor system and will be handled by bulldozer. At this stage, the gypgum should contain approximately 10 percent water and will not be subject to wind erosion. Therefore, the gypsum will not cause a fugitive-dust problem during transport.

If permanent disposal is necessary, the material will be landfilled in a heaped fill configuration as shown in Figure 4-17. This technique was found to be most adequate in view of the site's geologic and topographic characteristics. Experience with this type of landfill has shown that problems arising in the areas of ground-water pollution, slope stability, and site preparation are minimal in comparison with other disposal methods. Fugitive-dust problems are not expected, since the gypsum, when left undisturbed, forms a protective crust that minimizes wind erosion and dusting tendencies (Coltharp et al. 1979).

One disadvantage of this type of fill is its visibility; it tends to contrast markedly with surrounding flat terrain. To mitigate the aesthetic impact, the site will be screened from areas of public access with vegetation. Vegetative screening has been employed at the Big Bend site with excellent results. In addition, once a disposal phase is completed, topsoil and fertilizer will be applied before revegetation begins. Ground-cover species commonly used in the area, such as Paspalum notatum (Bahia grass), and Lespedeza repens (creeping lespedeza), will be used to complement naturally occurring species.

The parcels of land to be used for gypsum storage/disposal will be placed so as to minimize the disruption of existing drainage patterms. Newman Branch and adjacent wetlands will be protected from any potential runoff by the design and placement of dikes around the disposal sites. Any modification of the existing drainage patterns will continue to direct nongypsum-pile runoff into these wetlands. The main objectives in the design and construction of drainage modifications will be to minimize erosion and to maintain existing water quality.

The primary impact on terrestrial systems from the operation of the particulate control system will be the preemption of 121 acres for the settling ponds and disposal cells for bottom-ash, unmarketable fly ash, pyrites removed from the coal before combustion, and economizer ash (Section 6.12). The bottom-ash disposal site will be located in the area currently occupied by an unused cooling pond. The fly-ash disposal site will be adjacent to the bottom-ash pond on land that is classified as "old field." (Tampa Electric Company 1980b).

Other potential terrestrial impacts from the control of particulates include (1) the use of active disposal ponds by waterfowl and (2) the effects of runoff and seepage from disposal sites (Dvorak et al., 1978).

The presence of a large body of standing water can sometimes be attractive to waterfowl as a resting and feeding area, particularly if there are sources of food nearby. Ash-settling ponds are examples of such bodies of water. Waterfowl using these ponds are thus exposed to potentially harmful particulates and chemicals dissolved in the water.

During the operation of a powerplant, runoff from the onsite waste impoundment is unlikely if dikes for confinement of the waste ash are properly constructed. Vertical and lateral seepage from unlined ash disposal sites can occur, particularly where the waste material is deposited as a slurry. The major impact of seepage is the addition of potentially toxic elements and ions to soils, ground water, and surface waters. In addition, seepage may introduce radionuclides and other potentially harmful elements into the growth medium of local vegetation.

The bottom-ash settling ponds for Big Bend Unit 4 will be unlined and designed to store approximately 6 months of ash production. As these ponds are filled, the ash will be hydraulically dredged to final earthern-diked disposal cells.

The settling ponds and disposal cells for unmarketable fly ash, pyrites, and economizer ash will be lined and enclosed by earthern dikes. Liner material will have a low permeability (10^{-7} centimeter per second).

Noise impacts from powerplant operation are discussed in Section 6.3.1, and the potential effects of leachates from this site are discussed in Section 6.3.3.

6.3.2.2 Operation of a Mechanical-Draft Cooling Tower

The Applicant has sponsored studies for the prediction of salt deposition by drift (Stone & Webster Engineering Corporation 1979; Environmental Science and Engineering, Inc. 1980). The process of predicting salt-deposition rates from a cooling tower is an extremely complicated one, involving several interrelated processes, some of which are not fully understood. These processes include the behavior of the droplets within the tower; the dynamics of droplets in a moist, buoyant, rising plume; the breakaway point of the droplet from the plume; droplet evaporation; and dispersal by atmospheric turbulence. Tower characteristics such as circulating-water flow rate, drift rate, plume temperature, efflux velocity, salt concentration, and droplet-size distribution must also be known. In addition, ambient meteorological conditions that govern tower performance, droplet evaporation, plume rise, droplet transport, and dispersion are also required. The uncertainty connected with many of these parameters also makes it very difficult to accurately model cooling-tower drift deposition.

Several different drift-deposition models have been developed, each employing some simplifying assumptions in order to make the calculations feasible. The differences in the various modeling techniques naturally lead to some disagreement among the results of the various models. In a study conducted by Chen and Hanna (1977), in which 10 different drift models were compared using a standard set of input data, it was found that the model predictions of maximum deposition rate varied by as much as two orders of magnitude. The conclusion of the authors was that the major problem with drift modeling is the lack of verification of field data.

One of the Applicant's sponsored studies, which estimated deposition rate and air-borne particulate concentrations, used the Stone & Webster (S&W) Salt Drift Model, a combination trajectory and Gaussian model (Stone & Webster Engineering Corporation 1979). Deposition rates of droplets larger than 50 micrometers in diameter were calculated based on wind speed, fall velocity, and evaporation rate. Droplets smaller than 50 micrometers are treated as suspended particulates, and air concentrations are calculated using Gaussian dispersion equations. Plume rise is determined with the Briggs equations, and the droplet breakaway from the plume is a function of wind speed, droplet-fall velocity, and the upward velocity and size of the plume. The S&W model predicts salt drift in the middle of the range of predictions by various other models.

The input parameters used in the model were based on the mechanical-draft cooling-tower design summarized in Section 3.4.1.4. Additional airflow characteristics were furnished by a cooling-tower manufacturer. The design-tower drift rate was assumed to not exceed 0.002 percent. At this drift rate, salt emissions from the tower would be slightly more than 100 lb/hr. The meterological data were from MacDill Air Force Base for calendar year 1953. The droplet-size distribution in the drift from an experimental cooling tower at the Turkey Point Powerplant (located south of Miami, Florida) was selected for use in the model because the measurements encompass a more extended period of time than those of other distribution studies. These measurements were taken as part of a test program sponsored by the EPA.

The results of the drift predictions for the mechanical-draft tower are given in Table 6-10 and Figure 6-29, which show annual average deposition rates within approximately 1 mile of the tower.

The study suggests that there are two areas near the Big Bend Station of primary importance in evaluating the potential terrestrial impacts of cooling-tower salt emissions. One area consists of the palmetto-Juncus and palmetto-pine associations in the area adjacent to, and south of, the proposed cooling-tower location. The drift predictions indicate that this vegetation will receive the heaviest onsite soil application of salts, regardless of the tower-design alternative. Unfortunately, there are insufficient data on the salt tolerance of the plant species occurring in this area, and therefore the extent of injury and the species involved cannot be precisely determined.

The other area of primary importance lies to the east and southeast of the cooling tower. Within this area, crops like tomatoes, red peppers, sweet onions, and strawberries are grown commercially. Of these crops, tomatoes are regarded as moderately salt sensitive and peppers, onions, and strawberries as very salt sensitive (Hayward and Bernstein 1958; Nieman 1962; Bernstein 1964). Higher salt levels than currently exist are also expected in those areas where existing vegetation consists primarily of old-field species of herbaceous and shrub vegetation and salt-tolerant species such as mangroves and salt marsh grasses. The occurrence and salt tolerance of ornamentals in offsite residential areas are presently unknown.

The assessment of salt effects on vegetation in the area of the Big Bend Station must, of necessity, be only general and qualitative because most of the available data result from testing in the northeastern United States and involve plant species not found in the area of the Big Bend Station. However, two general criteria have been used to evaluate the salt damage that may result from the operation of a mechanical-draft cooling tower. The first criterion is based on studies by Curtis et al. (1977), which show that the monthly threshold value for salt damage is 8.9 lb/acre. The second criterion is an annual threshold value of 17.8 lb/acre, which is used by the staff of the Nuclear Regulatory Commission in assessing the potential for salt damage to vegetation at freshwater cooling-tower sites.

From the predicted salt levels and the available data on the susceptibility of vegetation to salt damage, it appears likely that much of the vegetation in the palmetto-pine and palmetto-Juncus associations will be severely injured because of foliar salinization. However, the permeability of the soils, combined with the high annual rainfall (approximately 50 in.) should reduce the potential for excessive accumulation of salts and thereby reduce the potential for impacts from soil salinization in the palmetto-pine and palmetto-Juncus associations.

The maximum monthly salt-deposition rates predicted in areas where agricultural crops are currently cultivated are presented in Table 6-12. Within the agricultural areas 3,000 to 6,000 feet to the east and southeast of the cooling tower, the predicted maximum monthly rates range from 1.5 to 8.8 lb/acre. With one exception, these are sufficiently below the damage criterion cited by Curtis et al. (1977), 8.9 lb/(acre)(mo). However, because a portion of one agricultural area receives up to 8.8 lb/acre for the month of June, there is the possibility of some crop damage in a portion of this area. In addition, on an annual basis, the predicted salt deposition of more than 20 lb/acre in these agricultural areas exceeds the annual criterion (17.8 lb/acre used by the Nuclear Regulatory Commission staff. Again, although it appears that some crop damage may therefore occur, the potential for damage (through either foliar or soil salinization) is low because of the frequency and the amount of rainfall in the area.

During 1980, the Applicant sponsored a study that attempted to simulate the effects of salt drift from a cooling tower on the commercially important local tomato crop (Stone & Webster Engineering Corporation 1980). From mid-April to early June, simulated cooling-tower salt drift was applied to field-grown tomato plants with a tractor-drawn spray apparatus. The testing was conducted on five rows (three test, two control rows) of "Tempo" tomatoes, each row containing 35 individual plants growing in a commercial field located approximately 1 mile southwest of the Big Bend Station. Because of schedule delays, the plants had been in the ground for approximately 5 weeks before the testing began and therefore were not exposed to the effects of salt deposition for an entire growing season.

In the testing, a range of salt-deposition levels was simulated by twice-weekly applications of saline solutions to three rows of plants; the solution salt concentrations were 0.2399, 2.399, and 9.595 g/ℓ per application, which simulated monthly salt-deposition levels of 1.1, 11.2, and 44.8 kg/ha, respectively.

Two additional rows served as controls. One row received applications of distilled water, and the other row was left undisturbed. Terminal leaves were collected from each plant in each row at 2-week intervals and analyzed for chloride content. Green tomatoes of marketable size were harvested twice during the program for a quantitative analysis of fruit quality and yield.

Concurrent with the salt-drift simulation study, the Applicant sponsored a program to monitor ambient salt-deposition rates at four sites in the vicinity of Big Bend. Samples were collected every 2 days from a collector apparatus consisting of a filter, a funnel, and a 1-liter polyethylene bottle mounted at a height of 8 feet above the ground at each sampling location.

Each sample was subsequently analyzed for total chloride and sodium content. The data collected from Station T-4 (Production Service Center) were not included in the analysis because of suspected contamination of the samples as a result of ongoing construction activities in the vicinity of the collector.

On the average, salt-deposition rates were greatest at the station located closest to Tampa Bay. The highest daily deposition rate measured in the study was 0.198 kg/ha (Station T-7, May 21-23). Based on this value, the ambient salt deposition for a 1-month period would total 5.94 kg/ha. The Stone & Webster Salt Drift Model indicates that the monthly salt deposition resulting from the operation of a mechanical-drafting tower would amount to 9.85 kg/ha in the agricultural area where the simulation study was conducted (1.2 kilometers southeast of the tower; Table 6-10). The maximum monthly total salt deposition expected from natural and cooling-tower sources (approximately 15.8 kg/ha) falls within the range of monthly deposition rates (1.1 to 44.8 kg/ha) tested in the drift-simulation study.

Statistical analysis of the leaf tissue chloride testing data indicated that chloride levels were significantly higher in the experimental rows (E-1, E-2, and E-3) than the control rows (C-1 and C-2) when initial differences (i.e., concentrations present during first sampling) among the rows were considered. The chloride concentration differences between the experimental and control rows reflect the foliar uptake of chlorides. While leaf chloride levels were higher in the three experimental rows, none of the three salt application levels produced visible symptoms of salt injury to leaves. Similarly, no symptoms of leaf injury were observed on plants grown in either of the control rows. Generally, there was an increase in leaf chloride concentrations during the second and third samplings for each of the five rows. However, there was a general decrease in chloride levels after the third sampling. This appears to have resulted from a change in leaf sample composition for each plant rather than an actual decrease in leaf chloride concentration. During the final two samplings, leaf samples consisted primarily of young leaves, which may not have been exposed to previous salt applications. This change in procedure occurred because there were fewer half-mature terminal leaves on the plants to harvest.

The analysis of fruit quality parameters indicated that there were no apparent deleterious effects of saline spray on tomato quality at the levels tested. Although slight variations were observed in measures of fruit quality, all reported values for both harvests were within acceptable ranges for commercially grown tomatoes.

The highest fruit yield (total number and weight of marketable tomatoes) was observed in Row E-2, which received a monthly salt application of 11.2 kg/ha; while the lowest marketable yields were observed in Row C-2 (control with no spray) and Row E-3 (receiving the highest monthly salt application, 44.9 kg/ha). With respect to the total yield (marketable yield, plus culls), the range of values obtained from all treatments and controls was very narrow (243.7 to 269.0 lb) and the pattern of response appears indistinct. The investigators suggested that it was not possible to statistically determine whether the differences between rows were within the range of natural variability or actually reflect a response to the application of saline spray.

An additional study sponsored by the Applicant to estimate the magnitude and distribution of particulate matter caused by drift from a mechanical-draft cooling tower was conducted by Environmental Science and Engineering, Inc. (1980). This study used the Oak Ridge Fog and Drift Model (ORFAD; LaVerne 1977).

The source parameters used in the model are listed in Table 6-13. Additional variables included ranges of drift-particle diameters (10-30, 30-50, 50-80, 80-110, 110-150, 150-200, 200-250, and 250-600 micrometers) and the weight fraction of drift-particle diameters in each range (8.1, 12.1, 16.4, 12.9, 13.0, 11.2, 7.5, and 18.8 percent, respectively). The meteorological variables used in the model included date, cloud ceiling, dry- and wet-bulb temperatures, relative humidity, wind speed and direction, and total sky cover. These data were measured as hourly surface observations at the Tampa International Airport, National Weather Service Office, from 1970 to 1974 and were obtained from the National Climatic Center. The additional variables inputted to ORFAD were the height of the temperature-measuring sensor (6 feet), the height of the anemometer (22 feet), and the height difference for temperature-difference measurements on the meteorological tower (defaulted to 100 feet). The hourly Pasquill stability class was determined internally by a preprocessor program, and the outputted variables included date, wind speed, and direction (16 sectors plus calm winds), dry- and wet-bulb temperatures, relative humidity, and stability class.

The drift was calculated downwind of the cooling tower at distances of 0.10, 0.20, 0.30, 0.40, 0.54, 0.75, 1.06, 1.50, 2.13, 3.00, 4.00, and 5.00 miles, and the results were then printed for the midpoints of these regions. A summary of the ORFAD model results is presented in Table 6-11.

The maximum drift due to the mechanical-draft tower was predicted to be 83 g/(m^2)(yr) and occurred 0.20 mile due west of the tower. The highest predicted drift for any other direction was 54 g/(m^2)(yr) and occurred at 0.20 mile east-northeast of the tower. The predicted annual average salt concentration was a maximum of 1.5 g/m^3 at a distance of 0.20 mile west of the tower.

The synergistic effects of cooling-tower drift and stack emissions (e.g., sulfur dioxide, nitrogen oxides, and particulates) represent an additional potential source of damage to vegetation near the Big Bend Station (Stone & Webster Engineering Corporation 1979). There is presently no evidence to indicate that existing stack emissions alone are causing stress to vegetation in the vicinity of the power station. However, the scientific literature indicates that increased humidity (such as would result from the operation of the cooling tower or the wet scrubber) increases the potential for vegetation injury through the formation of corrosive liquids (e.g., sulfuric acid) on plant tissue surfaces (Dvorak et al. 1978). It is also known that plant tissues that have been damaged by various agents (e.g., insects, mechanical breakage, or chemicals like sulfuric acid) are more susceptible to salt injury than undamaged, vigorous plant tissues (Roffman 1973). Therefore, the potential impacts of the stack emissions in turn affect the potential injury to plants from salt drift alone. There is presently insufficient biological information to assess the potential for impacts resulting from the synergistic effects of cooling-tower drift and stack emissions.

Potential noise and ground-level fogging impacts from the operation of a mechanical-draft cooling tower are discussed in Section 6.3.1.

6.3.3 WATER

6.3.3.1 Surface Water

6.3.3.1.1 Storm Water

The storm-water runoff from the proposed Big Bend Unit 4 may cause site ponding, site flooding, and soil erosion problems. The quality of the storm-water runoff may be contaminated by materials stored or spilled at the site area. Major sources of potential storm-water runoff impacts include the yard drainage system, the roof drainage system, the coal pile area, the FGD by-product storage/disposal area, and the ash disposal areas. The mitigative measures that the Applicant will use to control these impacts are described in Section 7.1.2.2.

6.3.3.1.2 Wastewater Discharges

Through the NPDES permitting process, water quality standard and standards of performance for new sources are applied to control the quantity and/or quality of the discharge of liquid effluents from Unit 4 (Tampa Electric Company 1981a).

During the construction of Big Bend Unit 4, there will be two discharges (Figure 6-30) associated with the installation of the circulating-water line: (1) construction dewatering discharge into the plant intake canal (NPDES No. 012) and (2) construction dewatering discharge into the plant discharge canal (NPDES No. 013). The point of discharge of No. 012 will be the eastern end of the intake canal. The point of discharge of No. 013 will be west of the Unit 3 condenser cooling-water discharge (NPDES No. 004), so that dewatering pumpage is not pushed into Jackson Branch during a rising tide.

Construction dewatering discharge will take place intermittently during the construction and installation of the circulating-water line. The frequency, quantity, and direction of discharge will depend on soil properties, the total length of excavated trench open at any time, and construction practices. It is estimated that there will be discharge of 70,000 gal/d based on an average discharge of 50 gal/hr for 24 hours. Since Big Bend Station and the construction site are surrounded on three sides by the waters of Hillsborough Bay (including the intake and discharge canals), the quality of the surficial ground water at the circulating-water-line excavation (i.e., that water subject to construction dewatering) is estimated to be similar to that in the intake and discharge canals.

There will be no discharge associated with the construction of the Unit 4 building and related facilities. Surface runoff will be intercepted and pumped to the wastewater treatment pond.

Discharges from the operation of Unit 4 will include (1) once-through cooling water (NPDES No. 008) or condenser-cooling-tower blowdown, depending on which cooling alternative is selected; (2) boiler blowdown (NPDES No. 009); (3) bottom-ash-system blowdown (NPDES No. 010); and (4) FGD-system blowdown (NPDES No. 011). A schematic of the plant water flow during the operational phase is presented in Figure 4-5, plant water use is described in Table 4-1.

Table 6-14 lists the continuous discharge streams, their expected contaminants, and the estimated concentrations of these contaminants. The combined effluents are the boiler blowdown, the bottom-ash blowdown, the FGD-system blowdown, and the once-through cooling-water discharge.

Boiler blowdown (30 gal/min) will not require treatment to meet effluent limitations. The bottom-ash-sluice system (80 gal/min) will allow for the settling of suspended solids before the discharge of blowdown. The FGD blowdown stream (70 gal/min) will be treated to remove suspended solids and adjust the pH to meet applicable effluent limitations. These three streams will be combined with the circulating water (241,200 gal/min) a minimum of 350 feet upstream from the point of discharge to provide for complete mixing prior to discharge.

Big Bend Station ambient intake-water-quality data for heavy metals are available for three study periods during the years 1970-1981. The first set of data was collected during biological monitoring studies conducted from 1970 through 1974. The second set was collected from June through September 1980 in conjunction with fine-mesh-screen studies for Big Bend Unit 4. A third set was collected during a study of the Big Bend slag pond from December 1980 through March 1981. The data from these studies have been submitted to the Florida Department of Environmental Regulation and EPA in conjunction with the site certification application and the NPDES permit application. A summary of the available data and the applicable Florida Class III water quality standards is provided in Table 6-15.

The data for 1970 through 1974 indicate that the average and maximum values for cadmium, chromium, copper, lead, and mercury and the maximum values for iron and nickel in the ambient intake water were above applicable Florida water-quality standards. No data for arsenic or selenium were collected.

The 1980 data indicate that the minimum, average, and maximum values for arsenic and selenium and the maximum value for mercury were above the applicable Florida water-quality standards.

The 1981 data, the most recent and detailed information available, indicate that the minimum, average, and maximum values for copper, lead, and mercury were above applicable Florida water-quality standards. However, the limit of detection for the chemical analytical method for lead is above the applicable Florida water-quality standard. The average and maximum values for cadmium, chromium, and selenium and the maximum values for arsenic, iron, and nickel also exceeded the water-quality standards. This analysis is presented in Table 6-16.

Based upon a review of the available data, it can be concluded that during various periods of time the concentrations of arsenic, cadmium, chromium, copper, iron, lead, mercury, nickel, and selenium exceeded the quality standards in the ambient intake water.

Predicted water quality data for Big Bend Unit 4--individual streams as well as the combined-discharge stream--is provided in Table 6-17. The data show that there will be no detectable change in water quality between the intake and the point of discharge.

Although it is possible to calculate very minor variations in the combined-discharge stream, these variations cannot be measured. This prediction is based on complete mixing within 350 feet of the circulating-water line prior to release into the discharge canal.

In view of the fact that the concentrations of certain of the above elements in the ambient water often violate water-quality standards, TECO, on April 13, 1981, applied for a variance (Tampa Electric Company 1981b) from those applicable water-quality standards to allow the discharge into Hillsborough Bay of the combined-waste stream from Big Bend Unit 4.

In support of the variance request, TECO considered alternative treatments of the discharge streams to remove heavy metals, assuming the individual streams could be treated to meet water-quality standards prior to mixing with the circulating water. The cost of such treatment was estimated as $1.2 to $1.8 million (1985 dollars), depending on the treatment method selected.

The estimated water quality of the blowdown streams after further treatment to remove heavy metals is provided in Table 6-18. Included in this table are estimates of the water quality of both the individual and combined-discharge streams for the different treatment alternatives. As indicated in these comparisons, there will be no measurable improvement in discharge-water quality as a result of the expenditure of an additional $1.2 to $1.8 million for further treatment.

Based on State and Federal regulations regarding the discharge of chlorine, the Applicant calculated a mixing zone for proposed Unit 4. The calculations assumed a constant release of 0.5 mg/ℓ and used dilution factors (Table 6-19) based on chlorine data collected for Units 1, 2, and 3. From these calculations, it was determined that approximately 6.1 acres would have a chlorine concentration in excess of 0.01 mg/ℓ. This area would be entirely contained within the discharge canal and would extend about 1,081 feet from the Unit 4 discharge outfall.

Table 6-20 presents information on the effects of chlorine based on 96-hour LC_{50} toxicity data for species (or their congeners) that are indigenous to the Big Bend area.

A value of 0.2 mg/ℓ is proposed as the limiting concentration for total residual oxidants (TRO) at the point of discharge. The rationale for this concentration is as follows:

1. Discharge limitations rarely exceed 0.2 mg/ℓ.

2. The 96-hour LC_{50} data provided to TECO and other data available indicate that 0.2 mg/ℓ falls within the range of tolerance for most organisms that could occur in the area.

3. Most of the affected organisms tested were juvenile. Generally, adult organisms can tolerate higher concentrations of chlorine, and adult species are more likely to be in the discharge canal; therefore, 0.2 mg/ℓ was chosen even though it is near the upper limit of the effects range.

4. Since the discharge canal is thermally stressed and has a positive discharge flow that tends to reduce the number of juvenile organisms present, a 6.1-acre mixing zone for chlorine should not have significant adverse effects.

Presently under review at the State and Federal levels is whether this limitation is adequate to protect aquatic organisms inhabiting the discharge canal. The resolution of this issue is expected before publication of the final EIS. Should the TRO concentration of 0.2 mg/ℓ be acceptable, it is expected that the Florida criterion of 0.01 mg/ℓ would not be exceeded outside of the proposed 6.1-acre mixing zone.

6.3.3.1.3 Thermal Effects

Another surface-water impact will result from the thermal discharge from the facility. Big Bend Station Unit 4 will use a once-through cooling system similar to that of existing Units 1, 2, and 3 (Section 4.2.4). The cooling water will be withdrawn from Hillsborough Bay via the existing intake channel and returned to the bay through the existing discharge channel. Figure 3-7 illustrates the cooling-water system of the three existing units and that proposed for Unit 4. The design-flow and temperature characteristics of circulating cooling water for Big Bend Units 1 through 4 are presented in Table 6-21.

As part of the demonstration for Big Bend Unit 4 pursuant to Sections 316(a) and 316(b) of the Clean Water Act of 1977, hydrothermal modeling was performed by the Applicant to determine the effects of the thermal discharge on the temperature of Tampa Bay. Two types of models, near-field and far-field, were used to perform this task (Tampa Electric Company 1980c).

The near-field model, a semiempirical model developed specifically for the Big Bend Station, was used to predict detailed temperatures near the station where the hydrodynamic characteristics of the discharge plume are more important than those of the receiving water body. The model simulates (1) a channel flow region, in which the flow is analyzed while it is within the discharge channel, and (2) a radial flow region, in which the flow is analyzed as it spreads laterally upon leaving the discharge channel. The plume is initially well mixed but becomes detached from the bottom and forms a surface layer flowing over the cooler ambient water at the point where the densimetric Froude number falls below some critical value. The plume then entrains a portion of the cooler bottom water at the interface, resulting in a reduction of the temperature rise of the plume. The model was calibrated with dye studies conducted at Big Bend in 1979.

The far-field model was used to determine the long-term buildup of heat (residual heat) in the vicinity of the station. It also determined temperatures at distances from the station where the near-field model was not applicable. The model, a finite-element dispersion model named DISPER-1, was developed at the Massachusetts Institute of Technology (MIT). It was used in conjunction with a finite-element hydrodynamic model named CAFE-1, which was also developed at MIT. CAFE-1 calculates current velocities and tide heights for use in DISPER-1.

The final results of the hydrothermal modeling were obtained by adding the far-field residual heat to the results for that area near the plant where the near-field model was applicable. For areas farther from the plant, where the near-field model was not applicable, the far-field results were used.

The results of the hydrothermal modeling for existing Units 1, 2, and 3 are shown in Figures 6-31 and 5-4 and in Tables 6-22 through 6-24. Figures 6-31 and 5-4 show the surface plume at 100 and 64 percent load, respectively. Associated surface areas enclosed by various temperature-difference (ΔT) isotherms are presented in Table 6-22, and Table 6-23 shows areas that the surface plume will sweep over a complete tidal cycle. Table 6-24 gives the distance from the point of discharge to the point at which the thermal plume becomes detached from the bottom. This table also gives the area of bottom contact of the thermal plume.

The results of the hydrothermal modeling for Units 1 through 4 together are shown in Figures 6-33 and 6-34 and in Tables 6-25 through 6-27. Figures 6-33 and 6-34 show the surface plume at 100 and 64 percent load, respectively. Areas that the surface plume will sweep over a complete tidal cycle are presented in Table 6-25. Table 6-27 gives the distance from the point of discharge to the point at which the thermal plume becomes detached from the bottom. This table also gives the area of bottom contact of the thermal plume.

Table 6-28 compares predicted condenser discharge temperatures with seasonal ambient water temperatures for the once-through cooling alternative.

Table 6-29 presents the predicted concentrations of various chemical constituents expected to occur in cooling-tower blowdown based on makeup-water concentrations and a concentration factor of 1.5. Table 6-30 compares predicted blowdown discharge temperatures with seasonal ambient water temperatures.

6.3.3.2 Ground Water

The environmental impacts on ground water of leachates and effluents from the proposed Unit 4 can be divided into two categories: hydrologic impacts, which are related to changes in ground-water quantity; and chemical impacts, which are related to changes in ground-water quality. As shown in Figure 6-35, the source areas of potential ground-water impacts at the site include the following:

1. Bottom-ash pond
2. Fly-ash pond
3. Limestone pile
4. FGD by-product storage/disposal area
5. Wastewater pond
6. Spray-irrigation field
7. Coal pile
8. Dredge disposal area

Areas 1 through 4 are associated with the operation of Unit 4, while Areas 5 through 8 are existing ground-water impact sources that are to be used by Unit 4. A discussion of the potential ground-water impacts of these source areas is presented below (Tampa Electric Company 1980b).

6.3.3.2.1 Ground-Water Quantity

The average hydraulic gradient in the unconfined aquifer measured at the site is westward (i.e., toward the bay) with a slope of approximately 6 x 10^{-4} ft/ft. The piezometric map of the unconfined aquifer at the site, as shown in Figure 6-2, indicates that ground water enters the site from the east and leaves the site either as ground water discharging into the bay or as stream flow from the drainage canals that intercept the water table and drain into the bay.

6.3.3.2.1.1 Bottom-Ash Pond

Preliminary calculations using flow nets show that approximately 250 gal/min of water will seep out of the bottom-ash pond into the surficial aquifer. This estimate is based on conservative values of hydraulic head, berm width, and aquifer hydraulic conductivity. The analysis indicates that almost all of the seepage will occur on the north, south, and west sides of the pond. Seepage from the east side of the bottom-ash pond will be restricted because of the impermeable liner in the adjacent fly-ash pond.

Normal leakage at the site area from the Floridan aquifer through the Hawthorn Formation into the surficial aquifer is estimated to be 0.0065 gal/(min)(acre). This estimate is based on the fact that the potentiometric surface of the Floridan aquifer is 1 foot higher than that of the surficial aquifer. The construction of the bottom-ash pond will reverse the hydraulic gradient in the Hawthorn Formation so that 0.16 gal/(min)(acre) will flow from the surficial aquifer into the Floridan aquifer directly beneath the pond. This estimate assumes a maximum hydraulic head differential of 29 feet between the water level in the pond and the potentiometric surface in the Floridan aquifer. Leakage into the Floridan aquifer is predicted to be 0.013 gal/(min)(acre) for the area (10 acres) adjacent to the pond where the water level will be raised in response to leakage from the pond into the surficial aquifer. Maximum leakage directly beneath the pond into the Floridan aquifer will be 0.29 and 0.13 gal/min from adjacent areas where the ground-water table is raised. Total leakage into the Floridan aquifer from the bottom-ash pond is predicted to be 0.42 gal/min.

Seepage from the bottom-ash cells will result from rainfall percolation through the material. Since the cell will be diked, rainwater in the dikes will either evaporate or percolate into the ground; none will run off. According to the hydrologic budget for Hillsborough County (Menke et al. 1961), approximately 40 percent of the rain falling into the cells will percolate into the ground.

6.3.3.2.1.2 Fly-Ash Pond

The fly-ash pond is expected to have minimal impact on the ground-water system at the site, because the pond will be sealed with a liner having a maximum permeability of 10^{-7} cm/s, as required by EPA liner specifications.

6.3.3.2.1.3 Limestone Pile

The limestone pile for the FGD system will be located on the peninsula and will cover an area of about 1.5 acres. The pile will be enclosed by a covered building so as to prevent any possible rainwater infiltration to the ground-water body through the limestone area.

6.3.3.2.1.4 FGD By-product Storage/Disposal Area

The FGD by-product storage/disposal area, located on the south of the bottom- and fly-ash ponds, will cover a total area of approximately 97 acres and will be developed in several stages. In order to contain the material, berms will be constructed around the entire area. These berms will be designed to withstand a 100-year flood and storm surge. Storm water falling within the bermed area will be directed to temporary storm-water storage in that area. It will then be allowed to percolate into the ground. There will be no direct discharge to any body of water (Tampa Electric Company 1981c). The quantity of leachate generated by the FGD by-product storage/disposal area will be minimized by diverting runoff and maximizing transpiration. The amount of leachate entering the ground-water system beneath the FGD by-product storage/disposal area will be equal to or less than the normal amount of ground-water recharge and therefore is not expected to have a hydrologic impact on the ground-water flow system.

6.3.3.2.1.5 Wastewater Pond

The existing wastewater pond is located north of the proposed fly-ash pond and south of the spray-irrigation field. It is approximately 900 feet long and 450 feet wide and is surrounded by berms that are built to a height of 12 feet above mean sea level.

The wastewater pond is underlain by the surficial aquifer. Water in the pond reaches a maximum hydraulic head of 11 feet above mean sea level. Figure 6-36 is a plan of the flow net of the wastewater pond; the berms are assumed to be impermeable. It is estimated that 300 gal/min of water seep out of the bottom of the pond into the surficial aquifer when the maximum hydraulic head differential of 7 feet is reached. This estimate is based on a conservative value for the hydraulic conductivity of the aquifer, 0.01 ft/min, and an aquifer thickness of 25 feet. The flow net shows that seepage occurs uniformly beneath the pond. However, seepage is slightly impeded toward the east in the upgradient direction.

An indirect measurement of seepage loss from the wastewater pond was performed by the Applicant in 1975. Inflow into the pond was determined using correlations with weir overflow, and the increase in storage of the pond was obtained from stage readings. The estimated seepage, the difference between these two quantities, was found to be less than 100 gal/min.

Leakage directly below the wastewater pond through the surficial aquifer into the Floridan aquifer is estimated to be 0.052 gal/(min)(acre). This assumes a hydraulic head differential of 8 feet between the water level in the pond and the potentiometric surface in the Floridan aquifer. Since the pond encompasses an area of 9.3 acres, approximately 0.48 gal/min leaks into the Floridan aquifer from the wastewater pond. Leakage into the Floridan aquifer from the area adjacent to the pond is negligible because of the minor amount of hydraulic-head buildup in the area outside the wastewater pond.

The normal seepage velocity in the upper sandy layer at the site is approximately $2x10^{-5}$ ft/min. The seepage velocity of the water seeping beneath the berms of the wastewater pond is estimated to be $2x10^{-3}$ ft/min.

6.3.3.2.1.6 Spray-Irrigation Field

The spray-irrigation field is location north of the wastewater pond and consists of four plots of naturally vegetated land that together cover an area of 29 acres, 21 of which are actually irrigated and 8 of which act as a buffer zone for the surrounding land. Decanted wastewater from the wastewater pond is sprayed on one plot at a time at an average rate of 177,000 gal/d. The spray-irrigation field is designed to prevent surface runoff.

For a conservative value of 20 percent of the spray effluent infiltrating into the ground-water system at the irrigation field, it is estimated that approximately 36,000 gal/d of recharge are added to the normal recharge rate in that area. As a result, a ground-water mound has formed beneath the spray-irrigation field. The size of the ground-water mound is determined by rainfall at the site, rates of spray irrigation and evapotranspiration, and the hydraulic conductivity and specific yield of the surficial aquifer in that area.

6.3.3.2.1.7 Coal Pile

Most of the leachate from the coal pile will be collected in runoff-collection ditches for transport to the wastewater pond. The amount of leachate that does infiltrate into the ground-water system is expected to be less than or equal to the natural amount of ground-water recharge. As a result, the hydrologic impact of coal pile leachate is predicted to be insignificant.

6.3.3.2.2 Ground-Water Quality

Previous water quality analyses of the site and adjacent areas show that the unconfined aquifer has saline water characteristics, relatively high concentrations of chloride (Cl), sodium (Na), sulfates (SO_4), and calcium (Ca). As shown in Table 6-31, the four sampling wells in the unconfined aquifer at the site have shown water quality exceeding the EPA drinking water limits for manganese, chromium, and total dissolved solids (TDS). Two of these four wells have Cl concentrations higher than the EPA limit. As a result, water in this aquifer cannot be used for human consumption without extensive treatment. From the limited available water quality data for the Floridan aquifer in the site area (Table 6-31), it can be seen that the SO_4 and TDS concentrations exceed recommended drinking-water limits (Tampa Electric Company 1980b).

The water quality of leachates produced from the various ponds and storage areas is discussed in the following sections. An analysis of existing and construction-induced seepage rates in the surficial aquifer, hydrologic boundary conditions, and other factors indicates that any leachate plume generated generally would be confined within the site boundaries and would ultimately be discharged by seepage to Tampa Bay. It is expected that the only wells to be affected by a leachate plume will be the TECO wells monitoring the quality of the ground water. The impact of leachates on water quality is expected to be minimal because of the poor ambient water quality, the dilution of leachates during migration, and ionic absorption in aquifer materials.

6.3.3.2.2.1 Bottom-Ash Pond

Migration of the leachate plume developing around the bottom-ash pond will be predominantly downgradient to the west. A comparison of the water quality of bottom-ash leachates with the ambient ground-water quality shows that the infiltration of bottom-ash leachates into the ground-water system will cause minimal impact on the ground-water quality at the site (Tampa Electric Company 1981).

Table 6-32 lists data on the water quality of the effluent produced at four different bottom-ash-disposal areas (Utility Water Act Group UWAG 1979). Included are data on effluent from a southern Illinois coal that is the coal most similar to the type proposed for use at Big Bend. The results of these studies have shown that the predicted water quality of the bottom-ash leachates conforms to EPA Drinking

Water Standards and Florida Department of Environmental Regulation Ground-Water Standards.

The UWAG study showed that the filtration of the bottom-ash effluents through clean, sieved sand produced an average reduction of 41 percent in the total arsenic concentration, 67 percent in total copper, 12 percent in total nickel, 33 percent in total zinc, and 38 percent in total manganese. These data are based on all fly-ash and bottom-ash effluents used in the study.

The native ground water in the Big Bend area has saline water characteristics, as evidenced by the relatively high concentrations of chloride, sodium, sulfates, and calcium in the surficial and the Floridan aquifers.

For these reasons, leachate from the bottom-ash-disposal area is not expected to have an adverse impact on ground-water quality at the site.

An alternative to the proposed unlined bottom-ash pond would involve the installation of a high-density polyethylene liner, which would eliminate the seepage from the pond. Similarly, lined disposal cells would not allow the percolation of rainwater through the ash into the ground water. The estimated cost of liners for the pond and cells is $2.1 million.

6.3.3.2.2.2 Fly-Ash Pond

The Applicant is currently evaluating various materials that can be used to line the fly-ash pond. Although a selection has not been made yet, the Applicant has stated that the liner will have a very low permeability (10^{-7} cm/s). The disposal of fly ash is therefore expected to have minimal impact on the ground-water system at the site (Tampa Electric Company 1980a).

6.3.3.2.2.3 Limestone Pile

Since the limestone pile will be enclosed by a covered building, it is not expected to generate any leachates.

6.3.3.2.2.4 FGD By-product Storage/Disposal Area

The infiltration of rainwater through the FGD gypsum by-product to the water table is a potential source of ground-water pollution. The permeability of the gypsum produced by the operation of the proposed Unit 4 is guaranteed by the FGD system vendor not to exceed 10^{-4} cm/s (2×10^{-4} ft/min). The exact water quality of the FGD system leachate at the site will depend on site-specific factors.

Most available data on FGD by-product leachates are representative of wet calcium sulfite sludges produced in existing FGD systems. These data are not representative of the material to be produced by the Big Bend Unit 4 FGD system. The Unit 4 FGD system will produce a material that is nearly pure gypsum (calcium sulfate). Since the FGD by-product will be gypsum and the FGD system will be located downstream from the precipitator, the major contributor to leachate contamination is expected to be calcium sulfate. Ground water i the area is typically high in sulfates; therefore, little impact is expected. There are presently no Class I-B Florida water-quality standards for calcium sulfate, calcium, or sulfates.

A recently released report (Electric Power Research Institute 1981) discusses the effects of the stacking and landfilling of FGD by-product gypsum from a test facility at Gulf Power Company's Plant Scholz in Sneads, Florida. The gypsum was sluiced to the disposal area at 5-10 weight percent solids. The decanted transport water was pumped back to the process for reuse. The gypsum settled to about 70 weight percent solids under the water surface.

The geology of the area (northern Florida) is very similar to that of Big Bend Station. The geologic sequence in ascending order consists of Eocene Gadsden Limestone, lower Oligocene Marianna Limestone, upper Oligocene Suwannee Limestone, Miocene Tampa Formation, and surficial soils of Pleistocene to Recent age. The surficial aquifer consists of silty and clayey sand 2 to 12 feet below the ground surface. The Floridan aquifer at the test stacking site averaged 60 to 65 feet below the ground surface. A liner was not installed within the gypsum-stacking areas. For ground-water monitoring, six observation wells were located in the silty and clayey soils of the surficial aquifer, two observation wells and two piezometers were placed in the aquiclude of the upper Tampa Formation, and three piezometers had collection zones in the Floridan aquifer of the Tampa Formation.

The stacking test period was from October 1978 through June 1980. The results of the monitoring program indicate the following:

1. No consistent increase in trace metals has occurred in either the surficial or the Floridan aquifer as a result of the operation of the disposal area.
2. Water quality within the deeper units of the Floridan aquifer has not changed from background conditions. Levels of all trace metals of concern are within the EPA interim primary drinking-water standards.
3. Water quality within the upper units of the Floridan aquifer immediately below the gypsum stack has improved slightly or has not changed.
4. Water quality within the surficial aquifer and within the aquiclude separating the surficial and the Floridan aquifers has improved slightly or has not changed.

It is important to note that approximately 12 feet of hydraulic head (decant water) was maintained throughout the test. This would tend to force leachate (if any) downward. Even with this driving force, however, no effects were conveyed (not sluiced) to the disposal area for stacking at about 90 weight percent solids. It will, therefore, have an insignificant hydraulic head, and the water in this drier gypsum will be purer than the process water used in the test stack.

6.3.3.2.2.5 Wastewater Pond and Spray-Irrigation Field

Certain waste streams from Big Bend Unit 4 will be channeled to the wastewater pond and sprayfield system currently used for the treatment of effluents from Units 1-3. The ground water at the Big Bend site has been designated as Class I-B in accordance with Florida water-quality standards. Data on the wastewater pond and sprayfield system indicate that average concentrations of chromium, selenium, and mercury and maximum concentrations of arsenic and cadium could exceed ground-water-quality standards. There are not data for lead concentrations, since the limit of detection for the lead test method is above the Florida water-quality standards. The only feasible method of treating the waters of the wastewater pond and sprayfield system involves routing them to surface waters rather than allowing them to percolate into the ground water. Such treatment, however, would defeat the purpose of the existing treatment facilities and could increase the concentrations of the above elements in surface waters.

The potential potable water supply at the Big Bend site is the underlying Floridian aquifer. It is conservatively estimated that less than 0.5 gal/min will seep into the Floridan aquifer as a result of the operation of the existing wastewater-treatment system; hence, no impact on the water quality of the Floridan aquifer is expected. Moreover, the general direction of flow in the Floridan aquifer at the Big Bend site is westerly. Any well downstream of the wastewater-treatment system would have to be located between the treatment facilities and Hillsborough Bay on property owned by the Applicant. In view of this fact, TECO has requested a variance (Tampa Electric Company 1981b) from the Florida water-quality standards for the concentrations of chromium, selenium, mercury, arsenic, and cadmium in discharges from the wastewater pond and sprayfield system.

6.3.3.2.2.6 Coal Pile

Coal-pile leachates generally have low pH values and high concentrations of iron, SO_4, and several trace metals. Since the peninsula on which the plant is sited is dredged material, the ground water beneath the coal pile is bay water. The chemical impact of the additional amount of leachate on the intruding bay water will have to be judged in terms of the quality of the ambient ground water and the amount of leachate generated by the proposed expansion of the existing coal pile, and this is difficult to predict (Tampa Electric Company 1980b).

6.3.3.3 Aquatic Ecology

6.3.3.3.1 Thermal Effects

After reviewing the Applicant's Section 316 demonstration (Tampa Electric Company 1977), which was based on studies conducted at Big Bend during 1976-1977 (Section 5.3.4.4), the U.S. Environmental Protection Agency (1980) made the following assessment of thermal effects of the operation of Units 1, 2, and 3 with dilution cooling on fish and invertebrate communities in the vicinity of the powerplant:

> Net studies conducted by seining and trawling both within and outside the expected thermal plume boundaries provide data on relative abundance, species composition, and community structure of fish in Hillsborough Bay.
>
> These data indicate that seasonal variation in species composition was similar to normal expectations for the Tampa Bay region. Temperatures in Hillsborough Bay due to the heated discharge did not appear to be a factor affecting the fish community.
>
> Considering the relative abundance and seasonal variations in species composition, the thermal discharges from Big Bend Station do not appear to interfere with the spawning of fish and shellfish in the Hillsborough-Tampa Bay area.
>
> The benthic regions off-shore of Apollo Beach and the Big Bend industrial site presently feature a sandy substrate of low organic

content, mixed with moderate to low amounts of silt and clay. The shoreline can be viewed as relatively high-energy beaches with depths quickly grading to a norm of 9-12 feet (2.7-3.7 meters). Seagrass is not now characteristic of the benthic environment and the only remnants of the shallow mangrove areas prevalent prior to the filling of Apollo Beach and the Big Bend industrial site are found in some areas of the northern embayment behind Apollo Beach.

Thermal impacts on the community of benthic organisms were intensively investigated at stations within and outside the thermal plume. Approximately 250 acres (101 ha), generally within one-half mile (0.8 km) of the point of discharge, are subject to slight to moderate impacts from the thermal discharge. Compared to non-thermal stations, stations in this area showed a marked reduction in species diversity and abundance. In addition, start-up of Unit 3 in May 1976 appeared to add to the stress condition and to cause changes in the benthic community such as reduced species diversity and abundance. Outside of the area within one-half mile of the place of discharge (POD), the benthic community appeared unaffected by increased temperature. Plume data indicated that because of thermal stratification much of the benthic community was spared exposure to excessive temperatures. In areas outside the one-half mile radius, indices of species diversity and abundance indicate little discernible effects of temperature. Sediment quality appeared as the primary factor affecting the distribution of macroinvertebrates.

With few exceptions, benthic data indicate that both the northern and southern embayments are moderately stressed in selected areas by reasons not directly attributable to thermal discharges. Both embayments tend to feature a benthic community more indicative of dead-end waterways. Thermal perturbations appeared in a shallow area in close proximity to the plant. Presently, the benthic community may be expressing effects of solar radiation and possible earlier thermal effects prior to modifications to the plant discharge. Considering results of other benthic studies in Tampa Bay, species richness and abundance appeared comparable or greater for the Big Bend area.

Severe thermal impacts from the Big Bend Station discharge were limited to the discharge canal, an area of about 10 acres (4 ha). The results of the benthic macroinvertebrate studies demonstrate the canal was severely stressed by high temperatures. This is most clearly shown by the kinds and numbers of benthos present. Since these organisms generally feature a lack of mobility and varied sensitivity to stresses, they are good indicators of long term environmental effects. The benthic community in the canal features a number of thermally tolerant species, including Nereis succinea among others; species which are not thermally tolerant have largely succumbed and have been replaced. The present community exhibits a high species diversity, high equitability, low faunal density, and a small number each of a number of species, indicative of a "pioneering" community in the discharge canal. Additional elevation of temperatures in the plume areas of Hillsborough Bay may be expected to result in an expansion of this "pioneering," thermally

> tolerant community into other benthic areas incurring excessive temperatures.

Based on this assessment of the thermal effects from the operation of Units 1, 2, and 3 with dilution assistance, the U.S. Environmental Protection Agency (1980) determined that

> . . . the present thermal discharge from the Big Bend Station is not causing an unacceptable adverse impact in Hillsborough Bay. Maintenance of heated discharge temperatures at, or below, present levels will continue to provide for the protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in and on the receiving body of water, Hillsborough Bay. Tampa Electric Company's 316 (a) Demonstration is, therefore, accepted for the existing facilities at the Big Bend Station. Modifications to the discharge structures implemented prior to startup of Unit 3 have succeeded in minimizing adverse thermal impacts in the northern embayment and this area is no longer subject to unacceptable thermal impacts.

The U.S. Environmental Protection Agency (1980) also determined, however, that

> . . . the location and capacity of the cooling water intake structures, including the dilution pump system, are the major factors causing an unacceptable level of entrainment and do not reflect the best technology available for minimizing adverse environmental impact.

The Applicant responded to this determination with a proposal to terminate use of the dilution cooling system and to provide for studies to assess the biological and associated thermal consequences of such action.

Retirement of the dilution pump system would reduce the withdrawal capacity of the Big Bend facility by 36 percent and would theoretically effect a proportional reduction in the level of entrainment. The EPA Regional Administrator viewed the Applicant's proposal as a means to establish a new basis from which to reassess the impact of entrainment on Hillsborough Bay.

The EPA reviewed the results of the Applicant-sponsored thermal and biological studies (Mahadevan et al. 1980; Tampa Electric Company 1980c) and developed a Tentative Finding and Determination (U.S. Environmental Protection Agency 1981a), which are provided below.

> The Big Bend Station operates three fossil fueled generating units with a combined rated capacity of approximately 1336 megawatts (gross). However, due to design deficiencies, the units in 1979 were limited to a combined rated capacity of approximately 1105 MW (hourly gross).
>
> Based on plant design information, operation of Units 1, 2 and 3 at the reduced operating capacity of 1105 MW should produce a condenser flow with a maximum temperature rise of 7.7°C (13.9°F). When dilution and condenser cooling flows are combined, a normal design maximum temperature rise of 5.1°C (9.1°F) would be expected

at the point of discharge. However, as shown by temperature records, temperature rises above these values do occur. For example, an average temperature rise of 7.2°C (13.0°F) was attained at the point of discharge during the months of July and August 1980. Also, maximum daily temperatures of 9.5°C (17.0°F) were frequently observed. During the July-August period, the average capacity factor for Units 1, 2 and 3 was 66 percent of the reduced maximum base load and 1105 MW or 55 percent of the facility's maximum design capacity of 1336 MW.

For 1979, the daily operating load for Units 1, 2 and 3 averaged 639 MW (48 percent of the maximum rated capacity). The maximum sustained station load for a 24-hour period was reported at 1074 MW. In the foreseeable future, plant modification could provide for a station capacity of 1275 MW with instantaneous peaks of 1336 MW, the design capacity of the facility. From 1976 to 1980, plant modifications have resulted in an increase in generating capacity of 1092 to 1130 MW for Units 1, 2 and 3.

From May through December 1979, TECO conducted an EPA approved biological study in the area of Hillsborough Bay receiving heated discharges from the Big Bend facility. The objective of the 8-month study was to evaluate changes in the benthic macroinvertebrate community relative to increased discharge temperatures caused by cessation of the dilution assist cooling system. Shut-down of the dilution assist cooling system occurred August 3, 1979.

Intake temperatures of the Big Bend facility were considered representative of ambient conditions. During 1979, reported daily intake temperatures peaked during the months of July and August when water temperatures ranged from 29.4°C (85.0°F) to 32.2°C (90.0°F) and yielded an average of 30.5°C (86.9°F) for the 2 months. Correspondingly, water temperatures at the point of discharge ranged from 32.8°C (91.0°F) to 47.2°C (117.0°F) with an average of 37.6°C (99.7°F).

During the course of the benthic macroinvertebrate investigation, the monitoring of plume configuration under field conditions was not required. Instead, results of thermal modeling efforts conducted by the company provided a comparison of average plume conditions relative to temperatures attributable to operation of the dilution assist cooling system. With Units 1, 2 and 3 at 64 percent of maximum rated capacity, the following table illustrates the expected surface dimension of the plume with and without operation of the dilution pump.

Isotherm (ΔT°C)	Area Hectares (Acres) With Dilution Pump	Area Hectares (Acres) Without Dilution Pump
1°	769 (1900)	923 (2280)
2°	340 (840)	437 (1080)
3°	109 (269)	219 (541)
4°	42 (104)	109 (269)
5°	5 (12)	55 (136)
6°	4 (10)	31 (77)
7°	no data	19 (47)
8°	no data	11 (27)
9°	no data	6 (15)

Because the average station load during 1979 was only 48 percent of the maximum rated capacity of the facility, the actual areal extent of the plume configuration should be less than projected by modeling results at 64 percent plant capacity.

Based upon results of the thermal modeling studies reported by TECO, heated effluent from the Big Bend Station will provide for a thermally stratified water column in Hillsborough Bay. At a distance of 300 m (328 yd) and 360 m (394 yd) seaward of the point of discharge, the plume is expected to detach from the bottom when Units 1, 2 and 3 are operated without dilution and at 64 and 100 percent of the rated capacity, respectively. The bottom area in direct contact with the plume would be approximately 5ha (12.4a) to 7ha (17.3a).

Compared to results of a 1976 investigation reported in a previously submitted 316(a) demonstration of the Big Bend facility, a general decline in the quality of the benthic macroinvertebrate community has occurred. However this decline, measured in terms of decreases in animal abundance and species diversity, appeared as an areawide trend in the Tampa-Hillsborough Bay and was not limited to the thermally affected region associated with the Big Bend facility.

Adverse impacts related to elevated temperatures following the shut-down of the dilution pump system appeared concentrated in an area adjacent to the facility's point of discharge. A measured decrease in faunal density and species richness was observed in the benthic animal community inhabiting approximately a 7ha (17a) area adjacent to the point of discharge. A preponderance of opportunistic and pollution tolerant species characterized the variety of benthic animals inhabitating the thermally stressed area. At the time of benthic sampling, the area of impact featured bottom temperatures which ranged from a high of about 34.0°C (93.2°F) in August to a low 23.0°C (73.4°F) in December. This area of impact represented approximately a 43 percent expansion of the thermally stressed environment previously limited to the station's discharge canal. The total area of benthic habitat subject to severe thermal stress, with shut-down of the dilution pump systems, measures about 23ha (57a).

Beyond the zone of primary impact, short-term adverse faunal effects were observed, but cannot be clearly related to water temperatures associated with the shut-down of the dilution pump system or operation of the Big Bend facility. Natural cyclic variations in the benthic animal community and areawide perturbations, such as siltation effects from the Bay deepening project, could also serve to explain the apparent trends in the quality of the benthic biota.

The benthic area adjacent to the point of discharge and subject to a persistent thermal impact is generally encompassed by the bottom contact boundaries of the plume as predicted by hydrographic modeling. The projected boundaries assumed no dilution and operation of Units 1, 2 and 3 at 64 and 100 percent of the design capacity of the units. However, actual plant operation was only 55 percent of maximum capacity for the period of July and August when peak ambient temperatures occurred. In 1979 the operation of Units 1, 2 and 3 averaged 48 percent of design capacity.

The biological studies showed that the area of adverse environmental impact exceeded the bottom area in contact with the projected plume. Thus, the dimensions of the plume projected by the hydrographic model cannot be utilized with confidence to predict the area of adverse thermal impact resulting from increased generation capacity. In view of this discrepancy, a linear extrapolation, which may overestimate perhaps to worst case situations, has been utilized to describe the potential area of adverse thermal impact expected to result from the combined effects of increased generative capacity and retirement of the dilution assist pumps. Based on a linear extrapolation, actual operation of Units 1, 2 and 3 at 100 percent capacity would double the area presently determined to be adversely affected by severe thermal stress.

Operation of Units 1, 2 and 3 at the currently established load regimen and without the benefit of a dilution assisted cooling system causes adverse impacts in approximately 23ha (57a) of benthic habitat, which includes the discharge canal. Further plant modification will provide for increases in the maximum load capability of Units 1, 2 and 3 and consequent increases in discharge temperatures. Such temperature increases will necessarily expand the boundaries of the current zone of thermal impact. Assuming that Units 1, 2 and 3 attain 95 percent of their design capacity, approximately 46ha (114a) of Hillsborough Bay, including the discharge canal, 16ha (40a), is expected to suffer adverse impacts. The 46ha (114a) area predicted by linear extrapolation, while providing living space for many benthic macroinvertebrates, is nevertheless a sandy, tidal swept, high energy environment which is essentially devoid of seagrass habitat and other highly valued habitat-forming communities, i.e., hard-bottom or coral.

From this evaluation, the EPA made the following determinations:

1. The proposal to reduce the withdrawal capacity of the Big Bend facility by retiring the dilution pump system provides a new

basis upon which to reassess the impact on Hillsborough Bay of entrainment to the station.

2. The Tampa Electric Company conducted studies adequate to demonstrate biological effects of elevated discharge temperatures resulting from cessation of the dilution assisted cooling system for Units 1, 2 and 3. The study was initiated in May 1979 and continued through December 1979. The dilution pump system was shut-down on August 3, 1979. The 8-month period of study included the time during which maximum ambient temperatures would occur in Hillsborough Bay.

3. Elevated discharge temperatures resulting from cessation of the dilution pump system caused a discernible thermal impact on the benthic invertebrate community of Hillsborough Bay. The zone of adverse impact measured approximately 7ha (17a) beyond the POD and represented about a 43 percent expansion of the thermally stressed region previously restricted to the discharge canal.

4. The entrainment level at the cooling water intake structure has been reduced to an acceptable level for the purposes of Section 316(b) of the Act.

5. The expected increase in the area of adverse environmental impact due to the thermal discharge from Big Bend Units 1-3 will not cause an unacceptable impact in Hillsborough Bay. The company's 316(a) demonstration is, therefore, accepted for the existing facilities.

After reviewing the Applicant's Section 316 Demonstration for the proposed Unit 4 (Tampa Electric Company 1980c), which was based on studies conducted at Big Bend made the following assessment of the thermal effects of the combined operation of Units 1, 2, 3, and 4 without dilution assistance:

> Addition of Unit 4 will bring the maximum capacity of the Big Bend Station to a nominal 1782 MW (gross). Operation of Unit 4 is expected to average 64 percent of its maximum design capability of 445 MW (gross).
>
> The proposed method for condenser cooling for Unit 4 is once-through which is the current cooling design for Units 1 through 3. Cooling water withdrawal is via a 25 foot deep intake canal connecting to a 35 foot deep ship channel leading to Hillsborough Bay. Rate of withdrawal is 537 cfs for each unit which effects a combined cooling water requirement of 2148 cfs. Based on design information, bay water as it is circulated through the condensers will experience a temperature rise of 9.3°C (16.8°F). Based on current thermal records temperature rises frequently exceed these values.
>
> With the addition of Unit 4 to the Big Bend Station, the current heat load to Hillsborough Bay is expected to increase by approximately 33 percent. Although temperature rises at the point of discharge will remain unchanged, the added thermal load to the

> bay will provide for an enlargement of benthic area presently subject to adverse effects. Based on a linear extrapolation, the operation of Units 1 through 4 without dilution assist cooling could potentially provide for an adverse impact to approximately 61ha (152a) of bay bottoms.
>
> The operation of Units 1 through 4 without a dilution assist cooling system will potentially cause an adverse thermal impact to approximately 61ha (152a) of benthic habitat. The thermal impact, however, would not be viewed as substantial or unacceptable in terms of thermal damage to the benthic biota of Hillsborough Bay, because of the sandy, tidal swept nature of the benthic area subject to the impact and the fact that it does not represent primary benthic habitat which includes seagrass and other habitat forming community.

On the basis of this assessment, the EPA determined that:

1. The operation of Units 1 through 4 without a dilution assist cooling system will potentially cause an adverse thermal impact to approximately 61ha (152a) of benthic habitat. The thermal impact, however, would not be viewed as substantial or unacceptable in terms of thermal damage to the benthic biota of Hillsborough Bay, because of the sandy, tidal swept nature of the benthic area subject to the impact and the fact that it does not represent primary benthic habitat which includes seagrass and other habitat forming community.

2. The expected increase in the area of adverse environmental impact due to the thermal discharge from Big Bend Units 1-4 will not cause an unacceptable impact in Hillsborough Bay. The company's 316(a) demonstration is, therefore, accepted.

6.3.3.3.2 Intake Effects

The intake of cooling water into powerplant condenser systems can produce ecological impacts from (1) the impingement of large aquatic organisms on the intake screening system used to prevent fouling of the plant condenser tubes and (2) the entrainment of aquatic organisms, smaller than the mesh of the screening system, within the plant cooling system.

6.3.3.3.2.1 Impingement

The assessment of impingement impacts at Big Bend is based on the results of studies conducted in 1976-1977 (Peekstok et al. 1977; Tampa Electric Company 1977) and 1979-1980 (Comp 1980; Robinson 1980; Tampa Electric Company 1980c) as part of the Section 316(a) and (b) Demonstrations for Units 1, 2, and 3 and the proposed Unit 4, respectively.

During the first study, the traveling screens of either Unit 1 or 2 were sampled for 24 hours at approximately 2-week intervals from January 1976 to March 1977. Sixty species of fish were taken in the impingement collections during the 15-month study period (Table 5-106). Six species accounted for 86 percent of the total number of individuals impinged: Anchoa mitchilli (bay anchovy, 39 percent), Bairdiella chrysoura (silver perch, 32 percent), Lagodon rhomboides (pinfish, 5 percent), Cynoscion arenarius (sand seatrout, 4 percent), Prionotus scitulus (leopard searobin, 3 percent), and Chloroscombrus chrysurus (Atlantic bumper, 3 percent). Fish impingement rates were greatest from July to September 1976 and from January to March 1977. The species that dominated the impingement catch during these periods were B. chrysoura (July-September) and A. mitchilli (January-March). These species were also the fishes most commonly impinged throughout the 15-month study.

The seasonal abundance (by quarter) of total fishes as well as that of the dominant taxa impinged during 1976-1977 are presented in Table 6-33. Also included are the mean daily impingement rates calculated for each quarter from the results of sampling every 2 weeks during that quarter. Size-frequency data for impinged individuals of the dominant fish taxa are presented in Figures 6-37 through 6-40. From the mean daily impingement rates and the total number of operating days for each of the three generating units at Big Bend, estimates were made of impingement levels that occurred during each quarter of the study period (Table 6-34). These levels were then added to yield the total estimated annual impingement (January-December 1976 and April 1976-March 1977) occurring at the Big Bend Power Station during the study.

Twenty-seven macroinvertebrate species were taken in the biweekly impingement collections made at Big Bend in 1976-1977 (Table 5-81). Six species accounted for 87 percent of the total number of invertebrates collected during the 15-month study: Penaeus duorarum (pink shrimp, 39 percent), Callinectes sapidus (blue crab, 13 percent), Limulus polyphemus (horseshoe crab, 13 percent), Portunus gibbesii (9 percent), Lolliguncula brevis (brief squid, 7 percent), and Squilla empusa (mantis shrimp, 6 percent). Macroinvertebrate impingement rates (Tables 6-33 and 6-34) were greatest during winter (January-March 1976 and 1977) and summer (July-September 1976). The impingement of P. duorarum and L. brevis was greatest during the summer, while C. sapidus, L. polyphemus, P. gibbesii, and S. empusa were impinged in greatest numbers during the winter. Size-frequency data for impinged individuals of the dominant taxa are presented in Figures 6-41 through 6-46. With the exception of L. brevis, the dominant invertebrate taxa had high survival rates after impingement on the traveling screens.

After reviewing the Section 316(b) Demonstration for Big Bend Units 1, 2, and 3, which was based on the studies conducted during 1976-1977, the U.S. Environmental Protection Agency (1980) determined that "the reported level of impingement does not appear to be a factor causing a substantial impact to the fisheries of Hillsborough Bay." The EPA further determined that "designing and constructing the cooling water intake structures for Units 1, 2, and 3 at the Big Bend Station without provision for returning viable fish and shellfish impinged on the intake screens to the environment may not reflect the best technology available for minimizing adverse environmental impacts" and that "evaluation of mechanisms to return impinged organisms in a viable condition should be undertaken."

As part of the Section 316(a) and (b) Demonstrations to assess the potential impacts of the proposed Unit 4, an impingement study was conducted at Big Bend from March 1979 to February 1980. All organisms impinged on the traveling screens of one of the three operating units during one 24-hour period were collected once every 2 weeks for the 1-year study period. While all impinged organisms were identified and counted, more detailed analyses were conducted on those select "representative important species" (RIS) taken in the collections (Table 5-55), a detailed impact assessment was reported only for these taxa.

A total of 3,100 fish representing 52 species and 4,576 macroinvertebrates representing 20 species were taken in the 552 hours of impingement collections made during the 1-year study. The numbers of RIS fish and invertebrate taxa impinged during each 24-hour collection period from March 1979-February 1980 are presented in Table 6-35. The numbers predicted to be impinged annually at Big Bend with continuous three- and four-unit operation, based on the data collected during 1979-1980, are presented in Table 6-36. The predicted monthly impingement rates for RIS taxa with continuous four-unit operation are presented in Table 6-37.

Bay anchovies were impinged in low numbers during every month except July; however, the largest number (64 percent) were impinged from November to January, the period when large numbers were also taken in trawl collections made in the intake canal (Section 5.3.4.5). Individuals impinged during the study period ranged in size from 32 to 68 millimeters (standard length) with a mean length of 50 millimeters. The wet weights of impinged individuals ranged from 0.3 to 4.1 grams and averaged 1.5 grams over the year.

Of the RIS fish and invertebrate taxa impinged during 1979-1980, silver perch ranked second in abundance. While individuals of this species occurred in most of the 24-hour impingement collections, the largest number (71 percent), mostly juveniles, were impinged from May to July; this was the period when large numbers were also noted in trawl collections. Impinged individuals ranged from 34 to 138 millimeters (standard length) in size and from 0.9 to 65.2 grams in weight; mean values for the study year were 53 millimeters and 3.4 grams.

During 1979-1980, pink shrimp were impinged in greater numbers than any other fish or invertebrate taxon (RIS or non-RIS) at Big Bend. Individuals of this species were found in all 24-hour impingement collections made during the study year but were impinged in greatest numbers from summer through late fall, generally corresponding to the period when pink shrimp were most abundant in trawl collections made in the Big Bend area. Impinged individuals ranged from 33 to 152 millimeters in total length and 0.5 to 35.5 grams in weight; mean values were 64 millimeters (total length) and 2.8 grams, indicating that primarily juveniles were impinged during the study year.

Blue crabs were found in the impingement collections during all months of sampling but generally occurred in low numbers. Their impingement was greatest during January and February sampling, when 69 percent of all those taken in the 1-year study were collected. Impinged individuals ranged from 12 to 176 millimeters in carapace width and from 0.1 to 242.7 grams in weight; mean values were 48 millimeters and 17.6 grams, indicating that mostly juveniles were impinged.

The remainder of the select RIS fish and invertebrate taxa were found only rarely (scaled sardine, spotted seatrout, black drum, stone crab) or not at all (tidewater silverside) in the impingement collections made at Big Bend during 1979-1980.

A total of 2,479 non-RIS fishes representing 47 species were found in impingement collections made during 552 sampling hours of the 1-year study (Table 5-107). The five most abundant taxa were sand seatrout (Cynoscion arenarius, 1,180 individuals), Atlantic bumper (Chloroscombrus chrysurus, 246), pigfish (Orthopristis chrysoptera, 145), pinfish (Lagodon rhomboides, 133), and Gulf toadfish (Opsanus beta, 126). Sand seatrout occurred in impingement collections during most of the study year but were most abundant from September to November, when individuals were predominantly young-of-the-year, probably the result of a spring-summer spawn. This species was also the most abundant non-RIS fish collected by trawl during the 1979-1980 studies at Big Bend, occurring in relatively high abundance in the intake canal. Atlantic bumper comprised only a small portion of the impingement catch during the study until the two collections made in October, when 211 individuals, mostly young-of-the-year, were taken. Pigfish were found in the collections from April through August, with the largest numbers occurring during June and July. Pinfish were present in the collections sporadically throughout the study year; the largest numbers (64 percent) were observed from late April through May. Gulf toadfish were collected in low numbers throughout most of the study period.

A total of 2,627 non-RIS macroinvertebrates representing 17 species occurred in impingement' collections made at Big Bend during 1979-1980 (Table 5-84). The horseshoe crab was the most commonly collected species, with 1,533 individuals impinged. The portunid crab, Portunus gibbesii, accounted for 17 percent of impinged non-RIS invertebrates, while the xanthid crabs (Hexapanopeus angustifrons, Hexapanopeus sp., Neopanope texana, Eurypanopeus depressus, Panopeus herbstii, and an unidentified species) comprised approximately 9 percent of the total number of non-RIS invertebrates collected.

After reviewing the Section 316(b) Demonstration for Big Bend Unit 4, which was based on the studies conducted during 1979-1980, the U.S. Environmental Protection Agency (1981b) determined that:

1. The addition of Unit 4 (with conventional once-through cooling) to the Big Bend Station will potentially increase the current impingement effects of Units 1 through 3 by approximately 33 percent.

2. Based on the results of the Fine-Mesh Screening Prototype Studies, sufficient information was provided to determine that the fine-mesh screening of intake structures is a viable technology that will minimize entrainment effects. Furthermore, the installation of fine-mesh screens on Big Bend Units 3 and 4 will provide for entrainment effects approximately equal to the current impacts associated with the operation of Units 1, 2 and 3 with conventional intake technology. The design modification effected by the addition of fine-mesh screens at the cooling water intake for Units 3 and 4 minimizes adverse environmental impact for the purposes of Section 316(b) of the Act.

An additional benefit of using the fine-mesh screening system on the intakes of Units 3 and 4 is the expected reduction in impingement resulting from a lower screen-face velocity (0.5 fps approach velocity) than that of conventional screens (1.45 fps). Furthermore, all organisms impinged on the fine-mesh screens will be automatically washed from the screens and returned to Tampa Bay via the organism-return system (Sections 6.3.3.3.2.3 and 6.3.3.3.2.4).

6.3.3.3.2.2 Entrainment

The entrainment of meroplanktonic organisms within the cooling-water systems of the Big Bend Station was evaluated in the Section 316(a) and (b) Demonstration studies conducted during 1976-1977 (Phillips et al. 1977; Blanchet et al. 1977; Tampa Electric

Company 1977) and 1979-1980 (Phillips et al. 1980a,b; Robinson 1980, 1981; Tampa Electric Company 1980c; Section 5.3.4.3).

The entrainment of meroplankton organisms within both the condenser cooling system and the dilution pumping system was evaluated from January 1976 to March 1977. The rates of entrainment in the condenser systems of Units 1, 2, and 3 were calculated from cooling-water pumping rates and meroplankton abundance estimates. The meroplankton estimates were based on organism concentrations in samples collected at approximately 2-week intervals directly within the condenser effluent of an operating unit (Station I-1 or I-13; Figure 5-22) at the site of discharge to the discharge canal. Meroplankton abundance in the discharge samples was considered a more reliable measure of the quantity of organisms passing through the condenser cooling system than were plankton densities in samples that were routinely collected in the intake canal (Station I-6) during the study. The latter samples were obtained by towing the plankton nets obliquely through the water column in front of an operating unit.

The number of meroplankton organisms passing through the dilution pumping system, and subsequently entrained in the condenser effluent water in the discharge canal, was calculated from organism densities in samples collected approximately biweekly at dilution-pump intake and discharge locations (Stations 0-8 and I-16). Samples were collected at these stations by making plankton tows obliquely through the water column; the density data used in the entrainment calculations were averaged for the two stations.

The plant operational schedule that was followed during the study period is presented in Table 6-38. When a generating unit was operational, a constant cooling-system pumping volume of 15.2 m^3/s (537 cfs) was assumed; a constant dilution pumping rate of 25.2 m^3/s (890 cfs) was assumed when that system was operational.

Estimates of the number of meroplankton organisms entrained within the cooling-water systems of Big Bend Units 1, 2, and 3 during 1976-1977 are presented in Tables 6-39 and 6-40. The investigators noted that these represent the best possible estimates from the data collected, but were undoubtedly influenced by the high sampling variability and state-of-the-art species-identification problems that are inherent in studies of this type.

The seasonal rates at which planktonic organisms are entrained depend on the cooling-system pumping rates, which are dependent on the operating status of the various generating units, as well as on the seasonal distribution and abundance of the organisms in the vicinity of the plant intakes. Operational data for the condenser-system circulating pumps and the dilution-system pump at Big Bend during the study period are in Table 6-38. During the 1-year period from January to December 1976, the condenser-system circulating pumps were operational at 66 percent of capacity (724 of 1,098 generating-unit days). The dilution pumping system was operational at 70 percent capacity (258 of 366 pump-unit days) during this period. Pumping was below the maximum three-unit capacity during this period because the newly constructed Unit 3 did not become operational until May and because of the periodic "outage" of each of the three units throughout the year. The annual entrainment of fish eggs and larvae during 1976 amounted to 8.6×10^{10} and 2.6×10^{10} individuals, respectively, within the condenser cooling system and 1.0×10^{11} and 1.3×10^{10} individuals, respectively, within the dilution pumping system.

During the 1-year period from April 1976 to March 1977, the condenser-cooling system and the dilution system were operated at 77 and 86 percent, respectively, of capacity (847 of 1,095 generating-unit days and 313 of 365 pump-unit days). The entrainment of ichthyoplankton during this period amounted to 9.9×10^{10} and 2.7×10^{10} eggs and larvae, respectively, within the condenser cooling system and 8.9×10^{10} and 1.1×10^{10} eggs and larvae, respectively, within the dilution pumping system.

Fish eggs were entrained within the plant cooling systems during all months except January, while larvae were entrained during every month of the 15-month study. The entrainment of fish eggs within the cooling systems was greatest from March through July; the entrainment of fish larvae was greatest from March to October.

Tables 6-41 and 6-42 presented data on the relative annual entrainment of ichthyoplankton organisms, grouped by family, that occurred within the plant condenser and dilution cooling systems during 1976, as summarized by the U.S. Environmental Protection Agency (1980) from data reported by Phillips et al. (1977). The families Engraulidae and Sciaenidae accounted for, respectively, 99 and 90 percent of all eggs and larvae entrained during the 1-year period. In the assessments of entrainment impact during 1976-1977 (Phillips et al. 1977), emphasis was placed on the following taxa: the bay anchovy (Anchoa mitchilli), which was the dominant fish species taken in ichthyoplankton collections at Big Bend and is an important forage taxon; members of the drum family (Sciaenidae), which include species of commercial and sport value in the Tampa Bay area and, along with the engraulids, numerically dominated ichthyoplankton catches at Big Bend; and the scaled sardine (Harengula jaguana), a species of potential commercial value as a bait fish in the area. Estimates of the monthly entrainment of these taxa at Big Bend, based on results of the 1976-1977 studies, are presented in Tables 6-43, 6-44, and 6-45, respectively.

Eggs of the bay anchovy accounted for 34 and 29 percent of the total annual entrainment of fish eggs within the condenser cooling system and the dilution pumping system, respectively, during 1976; larvae accounted for 88 and 84 percent of the total annual entrainment in the respective cooling systems. One or both planktonic life stages were entrained within one or the other cooling system during all months except January and December 1976 and January 1977. The highest numbers of eggs were entrained from April through July; the highest numbers of larvae were entrained from April through October. These months correspond to the periods when these developmental stages are most abundant in the Big Bend area.

The eggs of various Sciaenidae comprised 65 and 69 percent of the total annual fish eggs entrained within the condenser cooling and dilution pumping systems, respectively; larvae accounted for 2 and 5 percent of the total entrainment through the respective systems during the year. Entrainment values were calculated for sciaenids tentatively identified to the genus or species level, but, because the early planktonic stages of this family present identification problems, the assessment of impacts was considered most reliable by considering the combined number of family members as a whole. Sciaenid eggs were entrained within the plant cooling systems during all months except January 1976. Larvae were entrained every month except January, February, November, and December 1976. The entrainment of both eggs and larvae was highest from March through September.

The scaled sardine accounted for 0.7 and 0.1 percent of the total entrainment of fish eggs within the condenser cooling and dilution systems, respectively, at Big Bend during 1976; larvae accounted for 0.1 and 0.4 percent of the total larvae entrained in the respective systems. The eggs and larvae of this species were entrained only during the period from April to July.

The level of entrainment for invertebrate meroplankton at Big Bend was also estimated from collections made during 1976-1977 (Table 6-40). Of the invertebrate forms taken in the collections, only planktonic stages of the decapod crustaceans were adequately sampled with the coarse mesh (363-micrometer) nets used in the study. Therefore, entrainment estimates are considered valid for only these forms.

The annual entrainment of total invertebrate meroplankton during 1976 amounted to 5.4×10^{11} individuals within the condenser cooling system and 2.5×10^{11} individuals within the dilution pumping system (Table 6-40). During the 1-year period from April 1976 to March 1977, the annual entrainment amounted to 5.5×10^{11} and 2.1×10^{11} individuals in the respective cooling systems. The entrainment of invertebrate meroplankton occurred during all months of the study but was highest from April through October.

The impact of invertebrate-meroplankton entrainment at Big Bend during 1976-1977 was assessed by Blanchet et al. (1977). The assessment concentrated primarily on the four most abundant taxa in the collections and also on the stone crab, a species that is of commercial value in the adult stage and was entrained in appreciable numbers at Big Bend.

The pinnotherid crab Pinnixa sayana was the most abundant larval invertebrate collected in the vicinity of Big Bend during 1976-1977 and was also the species that was entrained within the plant cooling systems in greatest numbers. This species accounted for 43 and 32 percent, respectively, of the invertebrate meroplankton entrained during 1976. Seasonally, entrainment was highest from March to November (Table 6-46). The porcellanid crab Polyonyx gibbesi accounted for 20 and 40 percent, respectively, of condenser and dilution pump entrainment of larval invertebrates during 1976; entrainment was high from March to November (Table 6-47). The callianassid shrimp Upogebia affinis accounted for 8 and 9 percent of condenser and dilution pump entrainment during 1976, entrainment being high from March to October (Table 6-48). The xanthid crab Neopanope texana was entrained in greatest numbers from August to October (Table 6-49) and accounted for 8 and 3 percent of the invertebrates entrained in the condenser and dilution pumping systems. The entrainment of Menippe mercenaria (stone crab) larvae accounted for approximately 1 percent each of the total invertebrates entrained in the respective cooling systems at Big Bend during 1976; entrainment was greatest from April to October (Table 6-50).

Other taxa of commercial value in the Tampa Bay area were identified from the meroplankton collections during 1976-1977. Only a relatively few individuals (24) of Penaeus duorarum (pink shrimp) were identified from the collections in the vicinity of the power plant. Accordingly, few individuals were estimated to have been entrained during the study period: from July to December, 6.9×10^6 postlarvae within the condenser cooling system and 7.3×10^5 within the dilution pumping system. A single damaged postlarva of a member of the family Penaeidae (probably Trachypenaeus or Sicyonia sp.) was collected in a discharge sample during August. On the basis of this single occurrence, 2.4×10^6 individuals were estimated to have been entrained at Big Bend during the study period. A few zoeae identified as Callinectes sp. (blue crab?) were recorded from the meroplankton collections. This species is also listed as having been entrained during August 1976 and February and

March 1977 for a total of 1.4×10^7 individuals entrained during the study period, all within the dilution pumping system.

With Units 1, 2, and 3 operating, maximum cooling-water flows totaling 46 m^3/s (1,610 cfs) pass through the condenser cooling systems at Big Bend. Organisms entrained within the cooling water are then exposed in the condensers to increases in water temperature as great as 7.9°C (14.1°F) above ambient. Dilution-pump flow totals 25 m^3/s (890 cfs), or 36 percent of total combined plant cooling-water flows. The U.S. Environmental Protection Agency (1980) determined that:

> In the absence of substantial information to the contrary, it is assumed that pump pressures, mechanical and physical friction in the pumps, and the 5.1°C (9.1°F) . . . thermal shock associated with mixing of the condenser flows, will produce a mortality rate of 100% of organisms entrained in the dilution system.

After evaluating the entrainment data collected during 1976-1977, the EPA concluded that:

> Entrainment of eggs and larvae of fish and shellfish through the cooling water intake structures including the dilution pump system at the Big Bend Station is of sufficient magnitude to cause unacceptable adverse environmental impact in Hillsborough Bay.

The EPA further determined that:

> The location and capacity of the cooling water intake structures at the Big Bend Station are the major factors causing this unacceptable level of entrainment and do not reflect the best technology available for minimizing adverse environmental impact.

The Applicant responded to this determination with a proposal to terminate use of the dilution-assist cooling system and to provide for studies to assess the biological and associated thermal consequences of such action.

Retirement of the dilution-pump system would reduce the withdrawal capacity of the Big Bend facility by 36 percent and would theoretically effect a proportional reduction in the level of entrainment. The EPA Regional Administrator viewed the Applicant's proposal as a means to establish a new basis on which to reassess the impact of entrainment on Hillsborough Bay.

The EPA reviewed the results of the Applicant-sponsored thermal and biological studies (Mahadevan et al. 1980; Tampa Electric Company 1980c) and determined (U.S. Environmental Protection Agency 1981a) that:

> The reduction in capacity of the cooling-water intake effected by elimination of the dilution-assist pumps potentially represents a 36-percent reduction in entrainment losses. The entrainment level at the cooling-water intake structure has been reduced to an acceptable level for the purposes of Section 316(b) of the Act (Federal Water Pollution Control Act, 33 U.S.C. 1326). The expected increase in the area of adverse environmental impact due to the thermal discharge from Big Bend Units 1, 2, and 3 (without dilution assistance) will not cause an unacceptable impact in Hillsborough Bay.

> The Applicant's 316(a) demonstration is, therefore, accepted for the existing facilities.

Condenser entrainment was also evaluated from data collected during the 1979-1980 Big Bend Aquatic Ecology Studies. These studies were conducted to gather information for preparation of the Sections 316(a) and (b) Demonstrations for Units 1 through 4. The entrainment rates of a select group of RIS (Table 5-55) occurring with existing Units 1, 2, and 3 were extrapolated to that projected for four-unit operation. In contrast to the 1976-1977 studies, estimates of the number of organisms entrained in the plant cooling systems were based on meroplankton densities in samples collected biweekly with oblique plankton tows in the water column at intake Station A (Tables 5-56 through 5-63 and 5-68 and 5-69). Collections were also routinely made within the discharge effluent of one of the operating units (Station B) by allowing the nets to passively fish in the effluent current (the method also used during sampling at this station during the 1976-1977 studies). However, observations made during sampling at this station cast doubt on the reliability of this sampling method. (Water turbulence and relatively low current velocities may have precluded accurate measurements of water volume flow through the nets.) From these biweekly meroplankton-density estimates and cooling-water flow rates, monthly rates of maximum potential entrainment were projected for the combined operation of Units 1 through 4 at 100 percent flow capacity (Table 6-51).

After evaluating the Section 316b Demonstration for Unit 4, which was based on studies conducted during 1979-1980, the U.S. Environmental Protection Agency (1981b) determined that the Applicant's analyses fail to demonstrate the adequacy of conventional once-through cooling to minimize entrainment impacts. The EPA further concluded that:

> All stages of most species of meroplankton are attracted to and are concentrated in the intake canal. Such a phenomenon when accompanied by the increased intake (capacity) is indicative of an intake design which does not reflect best technology available to minimize adverse environmental impact.

6.3.3.3.2.3 Fine-Mesh Screening Studies

Because of the EPA's concern for the potential loss of organisms by entrainment in the Unit 4 once-through condenser cooling system, the Applicant undertook to evaluate various techniques for excluding entrainable organisms. A review of available intake techniques was conducted to evaluate the engineering reliability and appropriateness to the Big Bend site as well as the biological effectiveness. These evaluations indicated that fine-mesh screening had the greatest potential for effective application at Big Bend. Accordingly, in preliminary studies conducted during the summer of 1979, a partial fine-mesh screen was added to an existing traveling screen at Big Bend Unit 1; also included was a flume study in which various test organisms were impinged on a fine-mesh screen panel over a range of impingement velocities and durations. A detailed description of the facilities and methods employed and the results of the study have been presented by Tampa Electric Company (1980c). In summary, the survival rates observed in both test facilities were sufficient to warrant proceeding with additional investigations during 1980, using a prototype traveling screen equipped with a full-scale fine-mesh screen, including all features required for an in-service installation. A biological investigation with this prototype system was conducted from March to August 1980. A detailed description of the test facility, methods employed, and results of the prototype study are presented in another report (Tampa Electric Company 1980d). A summary of the study is provided below.

The prototype test screen was situated on a platform located in the intake canal of the Big Bend Power Station (Figures 6-47 through 6-50). The prototype screen was a dual-flow type and incorporated all of the features required for fine screening. Seals were incorporated between screen baskets and between the baskets and the side frame to minimize the passage of organisms through these areas. The screening medium was 0.5-millimeter mesh made of woven-monofilament polyester, and the 42 screen baskets were 2 feet wide and 2 feet high. The screen could be operated at speeds of up to 28 fpm; three speeds of 7, 14, and 28 fpm were selected for study. These speeds corresponded to maximum impingement durations of approximately 7, 4, and 2 minutes, respectively. Waterflow through the screen was supplied by an in-line pump (an adapted ship-bow thruster pump) located under the test platform and connected directly to the screen via a transition section.

Assorted pulleys allowed for flow adjustments. During the study, pulleys were selected to achieve approach velocities of 0.5 and 1.0 fps. The preliminary flume studies indicated that these impingement duration times and screen approach velocities were optimal for the survival of organisms.

The test screen incorporated shallow lifting buckets on each 2-foot-wide screen basket, which retained approximately 1 inch of water. A low-pressure (10-psi) spray header on the ascending side of the screen removed organisms from the screen-mesh surface and lifting buckets. A high-pressure (55-psi) spray header on the descending side of the screen removed any remaining debris into a separate trough. A screen-wash pump with a strainer was located on the operating deck, which took suction from the filtered water (bow-thruster pump discharge). As each screen basket passed the spray wash, organisms on the mesh or in the lifting bucket were gently rinsed into a collection trough. Once in the trough, the organisms flowed by gravity into a primary collection tank, from which they were drained into a secondary collection chamber. This collection chamber also served as the container in which the organisms were transported to the laboratory for initial and latent (up to 96-hour) mortality determinations.

In order to determine the survival of organisms after impingement on, and removal from, the prototype screen, screen samples were collected routinely throughout the study program. Tests were conducted with all combinations of screen travel speeds of 7, 14, and 28 fpm and approach velocities of 0.5 and 1.0 fps. The procedures used in all tests were as follows: before sampling, the bow-thruster pump and screen were set at the desired operating point for the specific test being conducted. The low-pressure spray wash was preset at 10 psi and was then shut off until the sample was taken. Once the screen was in full operation and the movement of water and organisms through the test facility was in a steady state, sampling was initiated by turning on the low-pressure spray, allowing the contents of a predetermined number of screen baskets to be rinsed into the collection trough, and then shutting off the spray. The number of baskets washed differed for each water-velocity and screen-travel-speed condition, so that at each condition the total volumes of water sampled by the prototype screen were equivalent. The organisms washed into the collection trough were carried into a primary collection area that contained a screened overflow (0.25-millimeter mesh). In this area, large debris (leaves, shells, ctenophores) could be removed as the area drained. Once the water level reached the bottom of the overflow screen, the sample was concentrated to the point where it could be drawn down into the secondary collection and transport chamber, where the sample was further concentrated. The drawdown was slow and gentle to avoid stress from high velocities and turbulence in the drain line and container. Once the sample had been completely transferred, the container was sealed and transported to the land-based laboratory for studies of initial and latent effects.

In addition to screen-wash samples, control organisms were collected and held for comparison with the latent mortality values experienced among organisms collected by the screen. Control organisms were collected from the intake canal by suspending a stationary plankton net in the canal flow (velocity ≤ 0.4 fps) for approximately 5 minutes. The net was then gently washed and the contents were transported to the laboratory, where the sample was sorted for the life stages of a select group of meroplankton organisms. Individuals of each life stage were then held for 96 hours.

During the study, emphasis was placed on obtaining survival data for life stages of a select group of RIS (Table 5-55). However, while species identification was generally possible in the screen-wash survival studies because of careful handling techniques, in most cases individual species did not occur frequently enough to permit a meaningful analysis of the data at the species level. Therefore, it was generally necessary to combine species into higher taxonomic groupings. For example, the three sciaenid RIS (black drum, silver perch, and spotted seatrout) were often combined into the grouping "sciaenids." As such, the data analyses were designed to include with these RIS all other sciaenids that occurred in each sample.

On the other hand, in some cases an RIS life stage always occurred in such abundance that it could always be analyzed at the species level. The eggs of the bay anchovy are the most notable example of such a life stage. Several RIS were never observed in screen-wash samples: pink shrimp, American oyster, and blue crab.

Tables 6-52 through 6-55 present viability data for the various larval stages of the fish and macroinvertebrate taxa impinged on the prototype fine-mesh screening system at Big Bend during the study period from March to August 1980. Included are data on the rates of initial survival, hatchability (of fish eggs), and latent survival after 48 and 96 hours under controlled laboratory conditions. Also included in the tables are viability data on the larval stages of these taxa, which were collected as control organisms for estimating the rates of mortality due not to screen impingement but to natural effects and the effects of handling and holding in the laboratory.

The viability of the larval organisms after impingement on the prototype fine-mesh screening system was found to vary with taxon and life stage. Of the taxonomic categories studied, initial survival rates were highest for the larvae of decapod crustaceans; on the average, more than 90 percent of these taxa survived. Fish larvae, as a group, suffered the highest initial mortalities after impingement; in most cases, survival rates averaged less than 20 percent. The mean initial survival rates for fish eggs ranged from 3 to 100 percent, depending on the taxon. Since egg-development time is generally less than the 96-hour holding period, the proportion of impinged fish eggs that hatched during the latent-mortality studies is a measure of the viability of these eggs. The mean hatchability for the study period ranged from 80 to 100 percent, depending on the taxon.

The proportion of organisms that were alive after being held in the laboratory for 48 and 96 hours was used as a measure of the latent effects of screen impingement. However, the investigators suggested that the high mortality of many of the meroplankton organisms held from 48 to 96 hours under controlled conditions may limit the usefulness of the 96-hour survival rates. As with the initial determinations, the latent-mortality rates of organisms impinged by the prototype screening system were also taxon- and life-stage-specific, as was the relationship between the rates of survival at 48 and 96 hours.

Viability data for control organisms were, in many cases, limited by the small number of observations. However, these data indicate that natural mortality and mortality due to laboratory-handling stresses are contributing factors in the mortalities observed among organisms impinged on the fine-mesh screens. Therefore, the estimates of test mortality presented in Tables 6-52 through 6-55 should be considered as the cumulative effects of impingement, laboratory-handling stresses, and natural mortality.

Statistical analyses were conducted to evaluate the effects of ambient water temperature, screen speed, and approach velocity on the viability of impinged organisms. The results of these analyses are presented in Tables 6-56 and 6-57. The analyses indicate that these variables explain relatively little (R^2 values ranged from 0.01 to 0.56) of the variability in survival rates of the meroplankton taxa studied. However, the variables that were most often statistically significant ($p \leq 0.05$) were water temperature and approach velocity. Latent mortality rates after 96 hours were highest for organisms impinged on the screens during the period of highest ambient water temperature (June-August). The data also indicated that the influence of water temperature was more apparent after 96 hours than after 48 hours. Mortality was greater at an approach velocity of 1.0 fps than at 0.5 fps. The investigators emphasized that, while both water temperature and approach velocity were, in several cases, significantly related to the mortality rates of organisms impinged on the fine-mesh screens, these variables explained relatively little of the variability in the rates.

6.3.3.3.2.4 Supplemental Studies

Spray-Wash Efficiency Study

Since the spray-wash system incorporated into the prototype screen represents a new design, the efficiency of the system in washing organisms into the collection trough was investigated. It was not expected that the system would be totally effective in removing organisms; however, it was expected that quantitative and qualitative data would identify potential design changes that would optimize system efficiency.

Samples were collected in a screened collection box as the water exited the debris trough on the high-pressure spray-wash side of the screen while the low-pressure spray wash was in operation (Figure 6-50). In this way, the number of organisms removed by the low-pressure spray could be directly compared to the number carried over to the high-pressure spray, and the efficiency of the low-pressure spray wash could be calculated. It was expected that the speed of the screen would influence cleaning efficiency, with efficiency expected to decrease as speed increased. Therefore, samples were taken at all three travel speeds (7, 14, and 28 fpm). Samples were also taken at both screen-approach velocities of 0.5 and 1.0 fps.

Each sample was collected by washing down the screened collection box and was then preserved for later analysis. Laboratory analysis consisted of enumeration, identification to lowest feasible taxonomic level, the determination of life stage, and size measurements (fish larvae only). Screen-efficiency samples could then be compared to a standard screen-wash sample taken at nearly the same time.

In order to conduct the data analysis, it was necessary to combine identified taxa into groups because, in most cases, a single species, genus, or even family did not occur frequently enough to permit a meaningful analysis. The taxonomic level of each group was determined as the lowest level that would allow the inclusion of all important taxa from both the spray-wash efficiency samples and the comparable screen-wash samples.

To determine the spray-wash efficiency for each taxonomic group, the numbers of organisms in the spray-wash and screen-wash samples were converted to numbers per cubic meter of water passing through the fine-mesh screen. Then, the percentage of organisms not removed by the low-pressure spray-wash system was calculated.

A total of 15 spray-wash-efficiency tests were conducted during the study program: 10 tests in April, 3 tests in June, and 2 tests in July. A listing of the taxa recovered and identified is given in Table 6-58. Anchoa mitchilli (eggs and larvae) was the only species that occurred frequently enough to be analyzed at the species level. All other species occurred in relatively low abundance in both screen-wash and spray-wash samples. Accordingly, these species were combined into larger taxonomic groupings.

The results of spray-wash efficiency testing are given in Table 6-59. Eggs showed the highest degree of carryover (i.e., were not removed from the mesh and lifting bucket by the low-pressure spray). Larvae were removed more effectively, but still showed a relatively high rate of carryover. Decapod zoeae were removed most efficiently.

The data were analyzed to determine whether screen speed (7, 14, and 28 fpm) or approach velocity to the screen (0.5 and 1.0 fps) influenced spray-wash efficiency. While it was expected that increased screen speed would decrease efficiency, this relationship was not detected for any of the taxa studied. Approach velocity appeared to influence Anchoa mitchilli and Perciformes egg carryover; fewer eggs were carried over at 1.0 fps than at 0.5 fps.

It was suggested that the power of the analysis may have been limited by the high degree of variability in the data (Table 6-59) and, with the exception of A. mitchilli, the generally low abundance of organisms tested.

Prototype Screening Efficiency

In order to determine the efficiency of the prototype screen in preventing the passage of organisms, whether through the 0.5-millimeter mesh or the various sealed areas in the screen assembly, samples of organisms present in the screened water were collected. Samples were preserved and processed in the laboratory. Laboratory analysis consisted of enumeration, identification to the lowest feasible taxonomic level, the determination of life stage, and size measurements (fish larvae only).

Samples were collected with a sampling pump (Figure 6-50) that discharged into two conical plankton nets submerged in tanks. The pump was run for at least 1 hour to obtain sample volumes no smaller than 100 cubic meters.

The analysis of screening efficiency was limited by a lack of data. A total of 10 tests were conducted; however, only the results of four (two at a screen speed of 7 fpm and two at 14 fpm) were analyzed. A listing of the recovered and identified taxa is given in Table 6-60. Anchoa mitchilli (eggs and larvae) was the only species that occurred frequently enough to be analyzed at the species level. All other species occurred in relatively low abundance in both screen-wash and screen-efficiency samples. Therefore, most of the remaining species were combined into larger taxonomic groupings. The mean percentage loss data are presented in Table 6-61 for each species or group that occurred in enough abundance for analysis. The available data indicated that a portion of the organisms were not completely screened. These loss data do not point out the causal agent. However, the investigators indicated that an analysis of the length of the larvae collected in the screen-wash and screen-efficiency samples suggested that organisms had passed between the seals.

Plankton Net Sampling

Plankton net samples were collected adjacent to the prototype screen structure using the techniques employed in the 1979 Aquatic Ecology Study (Phillips and Blanchet 1980a,b). Four replicate samples were collected on 1 day during each week of screen sampling at the same time that screen samples were collected. Samples were preserved for later processing. Laboratory analysis for RIS consisted of enumeration, identification to species or the lowest feasible taxonomic level, the determination of life stage, and size measurement (fish larvae only).

Species collected in plankton nets were compared with species collected in the screen-wash samples. With the exception of yolk-sac larvae of *Cynoscion nebulosus* and *Pogonias cromis* (which were found only in net samples in low abundance and only on one date), all species and life stages collected in the net were also recorded from the screen-wash samples.

The results indicated that, qualitatively, the prototype screen sampled nearly all species and life stages that were collected in plankton net samples from the plant intake canal.

Investigations of the Organism-Return System

An essential element of the fine-mesh screening concept is the system that returns the impinged meroplankton to Tampa Bay. The Applicant selected a trough design as the conveyance mechanism for the return of organisms to the Bay.

Flume Study. In order to evaluate the biological effects of travel through a return trough, survival studies were conducted with test animals placed in a circular flume. The flume was 12 inches deep and 9 inches wide, and had an outer diameter of 8.3 feet. Water contained in the flume was circulated at 2 fps by water-drive paddles.

Tests were conducted by placing individual groups of RIS life stages into the flume and allowing them to circulate at velocities of 2 fps for 1 hour, which is equivalent to traveling a straight distance of 7,200 feet. This velocity was considered by the Applicant to be sufficiently high to move organisms rapidly to a release site, but low enough to minimize damage from turbulence and abrasion. Test organisms were obtained from the prototype screen and, therefore, at the end of flume testing had experienced the entire process of impingement, removal, and transport.

Control organisms collected from the prototype screen were subjected to the same conditions, except that the water in the flume was not circulated. These organisms were collected after 1 hour to determine whether the flume-testing procedure contributed to any observed mortality.

After each test run, the organisms were removed from the flume by draining the water into a screened collection box. The organisms were then enumerated as live, stunned, or dead, and live individuals were held for 96 hours to determine latent mortality. Holding procedures were identical with those used in the prototype-screen evaluation.

Organism Survival Studies. In conjunction with flume studies, a study of organism survival in water from the proposed organism-return canal (ORC) was conducted during 1 week each month from June through August 1980. Organisms collected with a plankton net were sorted into batches of 30 (lots of 5) and held in the ORC water for 96 hours. In addition, control organisms collected with the net were held in the plant-intake-canal (PIC) water for a comparison of latent survival.

Although data for the flume and organism survival studies were collected independently, the statistical analysis combined all the data together. This was done to control for the large day-to-day variability in survival that often occurred. As discussed above, 96-hour control and test mortality was very high during the phase of testing when most of the flume and organism survival studies were conducted. Therefore, the investigators believed that it would have been of little value to analyze the 96-hour results. Accordingly, the analyses focused on 48-hour data, with 48-hour survival as the primary variable of interest. This variable is the percentage of organisms that survived flume tests, control tests, or PIC and ORC tests for 48 hours. The variable is actually the product of initial survival and 48-hour holding survival.

A total of 15 flume tests and 8 control tests were conducted. In addition, eight net samples of organisms to be held in the ORC and PIC water were taken on corresponding sampling dates. The 8 dates on which this sampling took place spanned the period from mid-June to mid-August 1980. Before this, a total of 18 samples of net-collected organisms had been held in ORC or PIC water. This earlier testing period occurred from late May to early June 1980.

Anchoa mitchilli and Harengula jaguana were the only species collected in sufficient abundance to be analyzed separately. Both of these species are RIS. All other species occurred in relatively low abundance. For this reason, most of the remaining species were combined into larger taxonomic groupings for analysis. A listing of the taxa and groupings used in this study is given in Table 6-62.

For the flume studies, the results represent the combined data of all the life stages. The results were combined because organisms that were placed in the flume as eggs often hatched before or during testing, and therefore the life stage at which testing had occurred could not be precisely determined. This occurred for all fish species but more frequently with organisms of the Perciformes group.

The analyses for Anchoa mitchilli, Harengula jaguana, and Perciformes flume tests (June through August) indicated that there was no significant difference between flume-test and control survival to 48 hours. Similarly, no significant differences were observed in 48-hour survival of organisms held in PIC and ORC water during either study period. Data on mean 48-hour total survival for these two species and the Perciformes group are presented in Table 6-63. These rates of survival represent the mean for flume and PIC/ORC survival tests that were conducted concurrently and therefore do not include data from the earlier (May 22 to June 3) sampling period.

The analyses for shrimp and crab zoeae included only the flume-test and control data (Table 6-63). These data indicated that there was no significant difference in flume-test and control survival for 48 hours.

There was enough data from the earlier (May 22 to June 3) sampling period to permit an analysis of crab zoeae held in ORC and PIC water, but shrimp zoeae were not abundant enough to permit analysis. These results indicated that there was no significant difference in 48-hour survival of crabs held in ORC and PIC water; the mean survival was 88 percent.

Evaluation of the Proposed Organism-Return Canal. Two potential sites were considered by the Applicant for returning the organisms removed from the proposed fine-mesh screening systems (Figure 6-51). The preferred site (Area 1) is a large, dead-end, undeveloped canal located approximately 300 meters (1,000 feet) north of the plant intake canal. The other potential site (Area 2) is off the breakwater to the south of Fish Hook Key. Of the two, Area 1 is much closer to the plant and therefore would allow for a faster return of the organisms with less potential for transport stresses. Because of flushing rates, it was thought that the ORC could differ in water quality from the PIC to the extent that organism survival would be affected. In order to identify any important differences in water quality between the ORC and the PIC, water quality and hydrographic and biological studies of each canal were made from May through September 1980.

Area 2 was considered an area of ambient bay conditions and acceptable water quality, should it be used. Therefore, biological and water quality data were not gathered for this location.

As shown in Figure 6-52, sampling stations were established in the PIC and the ORC. A complete discussion of sampling procedures and the data obtained are presented in another report (Tampa Electric Company 1980d).

The major conclusions made from the data collected during the study were as follows:

1. Hydrographic parameters (temperature, salinity, dissolved oxygen, and pH) were generally similar at the PIC and the ORC. Recurrent anoxic conditions were not present in either canal.
2. Values of water quality parameters (micronutrients, pesticides, and metals), chlorophyll a, and fecal coliform levels were generally low and similar in the two canals.
3. Phytoplankton, zooplankton, and meroplankton communities were generally similar in species composition and density in the two canals.
4. Overall, the major biological and water quality parameters of the two canals were similar, with small-scale variations occurring that were attributed to natural spatial patchiness in the estuarine environment.

Reentrainment Evaluation. The two candidate release areas were assessed for the potential for reentraining organisms released from a return trough. In the assessment, hydrodynamic models were used to simulate the movement of released organisms with relation to the intake flow. Because of the physical characteristics of the two areas, different hydrodynamic models were used for each area. Detailed descriptions of these models and associated assumptions are presented elsewhere (Tampa Electric Company 1980d).

The bathymetry of the ORC is shown in Figure 6-53. Organisms released into the canal would be expected to disperse along its length and, in time, would leave the canal as a result of tidal flushing and the inflow of screen-wash water. It was assumed that, once planktonic organisms left the canal, they would enter the intake flow and would be reentrained.

The strategy for the analysis was to introduce organisms into the ORC and simulate the rate at which they disperse out of the canal and become susceptible to reentrainment. A long retention time within the canal would allow organisms to grow and develop beyond the point where they would be susceptible to reentrainment in the intake structure. Susceptibility to entrainment is highly dependent on swimming ability and the behavioral response of organisms, both of which are functions of size and life stage.

The simulation of the organism flushing rate in the ORC used two release locations: one approximately 2,540 feet and another approximately 3,900 feet from the mouth of the approximately 4,000-foot-long canal. The analysis of two release locations in the canal permitted an evaluation of the effect of the release location on reentrainment rate. The results of these simulations are presented in Figure 6-54. The loss rate of organisms is dependent on the release location. The highest retention occurred with the release point located at the eastern end of the canal. With release at this location, more than 90 percent of the organisms would remain in the canal after 15 days and approximately 60 percent would remain after 30 days. If released at a point approximately 2,540 feet from the canal mouth, approximately 75 percent of the organisms would remain after 15 days and approximately 45 percent would remain after 30 days.

Given the reported rapid growth rates of fish and crustaceans while in the planktonic stage, the investigators suggested that most released organisms would develop beyond an entrainable size and life stage before leaving the canal. In addition, most invertebrate larvae and young of many fish species were expected to become demersal within the ORC. While some of these and other released organisms would reside in the vicinity of the station, as the organisms grew and developed, movement into the portions of Tampa Bay would occur. Because of the long retention time in the ORC and the other factors mentioned, it was predicted that few organisms released near the east end of the canal would be subject to reentrainment.

The alternative release location at Fish Hook Key was evaluated by simulating the dispersion of organisms from the midpoint of the breakwater within the nearby region of Tampa Bay. At a point just north of Fish Hook Key, organisms were considered reentrainable in the intake flow. Assuming a constant release rate of organisms, the density of organisms at the point of reentrainment was calculated and the intake flow rate was used to determine the rate of reentrainment. While the results did not quantify the reentrainment rate, the investigators believed the analysis demonstrated that the reentrainment rate would be high and therefore this location would be less desirable as a release location for screened organisms.

The results of the evaluation suggested that few organisms returned to the east end of the ORC would be subject to reentrainment. The Applicant therefore selected the ORC as the preferred release location.

after reviewing the fine-mesh screening studies, the U.S. Environmental Protection Agency (1981b) developed a Tentative Finding and Determination, the conclusions of which are as follows:

1. The prototype device appeared to be approximately 56 percent effective in screening eggs and larvae from source water. Suggested changes in the design of the spraywash system, lifting buckets and seals are proposed as means to substantially improve the screening efficiency of the intake device.
2. Fish eggs and invertebrate larvae collected from the fine-mesh screen exhibited a low level of mortality. Many of the taxa involved were species of sport and commercial value, i.e., stone crab and drum.
3. Fish larvae collected from the fine-mesh screens or by plankton nets for control tests exhibited a high degree of mortality. The observed mortality, however, cannot be concluded to be solely due to impingement effects of the fine-mesh screen. Testing procedures, i.e., sampling and hauling, can be viewed as factors contributing to the apparent low survival of the larval organisms. The immediate return of animals upon collection from the screening device may enhance the survival of fish larvae.
4. The proposed transport systemof animals to the dead-end waterway north of the plant appears to be an acceptable organism return system. Additional testing is necessary to verify the dispersion of returned organisms to Hillsborough Bay.
5. Based on the results of the Fine-Mesh Screening Prototype Studies, sufficient information was provided to determine that the fine-mesh screening of intake structures is a viable technology that will minimize entrainment effects. Furthermore, the installation of fine-mesh screens on Big Bend Units 3 and 4 will provide for entrainment effects approximately equal to the current impacts associated with the operation of Units 1, 2 and 3 with conventional intake technology. The design modification effected by the addition of fine-mesh screens at the cooling water intake for Units 3 and 4 minimizes adverse environmental impact for the purpose of Section 316(b) of the Act.

6.3.4 PEOPLE

The proposed Big Bend Unit 4 is scheduled to begin operations in 1985. This section discusses the socioeconomic impacts associated with the operation of that unit.

6.3.4.1 Employment

The operation of Unit 4 is expected to create 50 permanent jobs. It is expected that the Tampa labor market will supply most of the skills necessary to operate the plant, and that, wherever possible, TECO will hire workers from the local market (Tampa Electric Company 1979). Although no estimate of the number of operating and maintenance personnel to be hired locally has been provided, it may be reasonably assumed that the percentage will approximate that of the construction work force, or 90 percent. Thus, it is assumed that 45 of the operating and maintenance personnel will be hired locally, and 5 persons will relocate to the area.

6.3.4.2 Wages of Operating and Maintenance Personnel

It is estimated that $1,400,000 per year (expressed in 1985 dollars) will be paid to Unit 4 operating and maintenance personnel (Tampa Electric Company 1979). An estimated $1,188,500 (1985 dollars) of this average annual total, based upon national characteristics (U.S. Department of Commerce 1979), will be disposable income, all of which is expected to be spent in the Tampa area.

The $1,400,000 in wages estimated for the Unit 4 operating and maintenance work force represents only 0.04 percent of the total personal income in Hillsborough County in 1977. Thus, the overall benefit to the area economy deriving from wages paid to operating and maintenance personnel should be limited.

6.3.4.3 Community Facilities and Housing

If it is assumed that 90 percent of the operating and maintenance work force for Unit 4 are hired locally, then the number of relocating workers, and hence the total in-migrating population (including persons associated with the relocating operating and maintenance personnel), should be negligible. Therefore, no significant impacts are expected with regard to the demands of relocating personnel on existing housing or on community facilities and services.

6.3.4.4 Transportation

During the operation of Unit 4, it is estimated that approximately 50 vehicles (one vehicle per operating employee) will be driven to and from the site, thus adding approximately 100 vehicle trips to the local traffic flow. In light of the number of vehicles presently using U.S. Highway 41 and projections as to the future use of the Hillsborough County highway network (Section 6.2.4.5), the impact of the vehicular trips to and from the station during the operation of Unit 4 is not expected to be significant.

The operation of Unit 4 will require additional shipments of coal and consumable supplies. Although the number of shipments and specific modes of shipment have not been determined, no significant impact on local transportation is expected.

6.3.4.5 Land Use

The operation of Unit 4 will not require the use of additional land resources. At the end of the operational life of the unit, it is expected that the 97-acre FGD by-product disposal/storage area will become public open space.

6.3.4.6 Radionuclide Emissions

During the combustion of coal, naturally occurring radionuclides contained within the coal are released to the environment. The primary radionuclides emitted are potassium-40 (K-40), uranium-235 (U-235) and its decay products, uranium-238 (U-238) and its decay products, and thorium-232 (Th-232) and its decay products. Potassium-40 is present in the coal in an amount equal to 0.0118 percent of the total K present (Dvorak et al. 1978).

According to Dvorak et al. (1978), the U-235 decay series does not contribute significantly to the radioactivity emitted. The U-238 and Th-232 decay series provide the majority of the radioactive effluents. Swanson et al. (1976) report average U concentrations of 1.0 ppm in a northern Appalachian coal and 1.4 ppm in an eastern interior coal. Thorium values of 2.8 and 2.6 ppm, respectively, were reported for the same coals. With the exception of radon gas, which will be emitted into the atmosphere during combustion, it is expected that the majority of radionuclides from the coal will be concentrated in the fly ash. Coltharp et al. (1979) found that Illinois basin coal, similar to one of the coals proposed for Big Bend 4, produced a fly ash with U and Th concentrations of 30 and 54 ppm, respectively, by weight. Krieger et al. (1978) have analyzed the radionuclide content of coal bottom and fly ash from a western Kentucky coal. Their data are summarized in Table 6-64.

Dvorak et al. (1978) provide estimates of average radionuclide-emission rates for various sizes of coal-fired plants. These data have been extrapolated to obtain the values presented in Table 6-65 for a 417-megawatt unit (note that the relationship between data points is approximately linear).

The U.S. Environmental Protection Agency (1979b) has made preliminary projections of the heatth impact of radionuclide emissions from coal-fired powerplants. It uses a model for new plants (RCM-1) based on a 550-megawatt unit burning a western coal with a radionuclide content higher than that of coals under consideration for Big Bend 4. Radioactive particulate emissions from this model plant would expose the population of a suburban area to the following radiation dose per organ:

Organ	Maximum individual dose (mrem/yr)
Lung	1.1
Bone	2.1
Kidney	1.0
Liver	0.9
Thyroid	1.1
Gastrointestinal tract	0.8
Other soft tissue	1.1

The model plant would also pose the following individual lifetime and fatal cancer risks to that suburban population:

Risk category	Risk
Individual lifetime risk	
Maximum individual exposure	1.4×10^{-5}
Average individual exposure	4.8×10^{-7}
Expected fatal cancers per year of operation (fatal cancers)	1.7×10^{-2}

Table 6-66 compares the human dose rates (per organ) attributable to emissions from a 1,000-megawatt coal-fired powerplant and those derived from natural background radiation. As can be seen from the data in this table, the normal annual radiation-dose commitment of an individual would be only negligibly increased by the operation of a plant more than twice the size of Big Bend.

6.3.4.7 Contamination of Electrical Equipment From Cooling-Tower Operation*

Salt drift or other contaminants (e.g., dust) may be deposited on insulators to form a film that, when moist or wet, reduces insulation strength and may result in flashovers. Flashovers may cause transmission interruptions and can lead to station outage.

Characteristically, in areas of atmospheric contamination, contaminants accumulate on insulators during periods of little or no precipitation. If the accumulation is electrically equivalent to 0.1 mg/cm^2 or more of sodium chloride, insulation strength could be reduced to unreliable levels during periods of fog or light rain. Accumulations significantly greater than 0.1 mg/cm^2 could result in multiple flashovers within a short time, possibly resulting in the shutdown of the substation. Rainfall, especially if accompanied by wind, can wash soluble or loose contaminants from the surfaces of porcelain insulators and restore insulation strength to normal. Hence, the effects of contamination on outdoor insulators is dependent on the characteristics of the contaminant(s) and on weather conditions.

At transmission facilities located near the coast, flashovers can be induced by natural airborne salt levels, particularly during extended periods of no rainfall or during severe coastal storms that deposit large amounts of salt during a short period. However, indications are that these are generally infrequent. The installation of a closed-cycle cooling system would increase the salt-drift levels and thus the potential for flashovers and station outage.

In attempting to correlate the levels of salt drift that may affect electrical insulators, the following factors must be considered:

1. Type of cooling tower
2. Cooling-system design parameters
3. Droplet-size distribution
4. Wind direction and frequency
5. Height of insulator above ground
6. Critical amount of salt that accumulates on an insulator to cause flashover
7. Type of insulator
8. Amount of airbone dust
9. Frequency and amount of rainfall
10. Relative humidity

Insulators mounted at higher elevations above ground, as on transmission lines, are usually subject to greater amounts of salt drift at a given distance from the towers. In one study, salt accumulation on insulators was shown to be two to three times greater at 100 feet than at 30 feet above ground level (Laskowski 1978).

Limited research has been conducted to determine the critical amount of salt accumulating on an insulator that will result in flashover. A salt accumulation of 0.1 mg/cm^2 has been suggested as a contamination level classification of moderate to heavy, as shown in Table 6-67. However, this value can only be roughly correlated to flashover potential. The type and length of insulator will affect the exact degree of contamination required to produce flashover. For example, salt can accumulate from salt drift and from salt contained in dust particles. Thus, the amount of airborne dust at a given site must be considered in addition to the salt deposited by the cooling system.

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*Stone & Webster Engineering Corporation (1979).

Two other meteorological conditions influence the amount of salt that accumulates on an insulator. Relative humidity appears to be an important variable since it affects the wetness of drift particles and thus their ability to stick to an insulator. For example, preliminary information for a plant in a desert area, where relative humidities are generally low, indicates that salt-drift deposition on insulators could be 2.5 times greater if all particles, not only wet particles, are assumed to adhere. In a more humid area, this difference is expected to be smaller. The time between rainfalls is also important, because salt will continue to accumulate unless it is removed by a sufficiently heavy rainstorm or by maintenance. There does not appear to be any specific information relating the rainfall intensity and duration required to wash salt from insulators.

Using the salt-drift predictions discussed in Section 6.3.2.2, a preliminary examination was made of the potential for salt drift affecting electrical insulators at the switchyard location for the Big Bend site. The following assumptions were made for this assessment:

1. An accumulation of 0.1 mg/cm^2 on an electrical insulator is the critical level that will result in the potential for flashover. This value is based on laboratory studies (Engineering Research Council 1975; Flanagan 1971; Kawai and Sforzini 1974) and is used here because it appears to be the only relevant information. It should not be interpreted as a definitive standard.

2. A period of 2 months passes without a rainfall of sufficient magnitude to wash insulators clean of accumulated salts.

3. The insulators are located at ground level rather than at some higher elevation.

4. All salt drift impinging on the insulators adheres to the surface and accumulates.

Based on the first two assumptions, the critical salt-deposition level would be equivalent to about 4.5 lb/(acre)(mo). The predicted monthly deposition levels at the existing switchyard area are approximately 10 to 15 lb/acre for the mechanical-draft towers. Although these predicted values exceed the critical monthly level of 4.5 lb/acre, the difference is not great considering the uncertainties in estimating many of the variables involved. This aspect should be explored in greater detail if a cooling tower is eventually selected for Big Bend Unit 4; however, it does not appear that potentially adverse effects on the switchyard would preclude the use of a cooling tower at the Big Bend site.

Table 6-3. Plant PSD operating and pollutant emission parameters for Big Bend Units 1-4

Unit/load percentage	Generation (MW)	Heat input rate (10^6 Btu/hr)	Flue-gas rate (1,000 acfm)	Flue-gas temperature (°F)	Stack height (ft)	Stack ID (ft)	Emission rate (lb/hr)		
							SO_2[a]	Particulate matter[b]	NO_x
Unit 1									
100%	362	4,037	1,276	301	490[c]	24[d]	20,936	404	2,826
75%	272	3,142	1,020	282	--	--	15,702	302	2,202
50%	191	2,143	724	261	--	--	10,468	202	1,500
Unit 2									
100%	338	3,996	1,276	301	--	--	20,723	400	2,797
75%	254	3,110	1,020	282	--	--	15,543	300	2,177
50%	169	2,122	724	261	--	--	10,362	200	1,485
Unit 3									
100%	362	4,115	1,285	292	490[c]	24[d]	21,341	411	2,881
75%	272	3,203	999	268	--	--	16,005	309	2,249
50%	191	2,185	693	249	--	--	10,670	206	1,530
Unit 4									
100%	417	4,330	1,778	156	--	--	5,630[e]	141[e]	2,598[e]
75%	313	3,244	1,422	156	--	--	4,223	106	1,946
50%	209	2,241	1,013	156	--	--	2,815	70	1,345

Abbreviations:

PSD = prevention of significant deterioration.
ID = internal diameter.
acfm = absolute cubic feet per minute.
SO_2 = sulfur dioxide.
NO_x = nitrogen oxides.

[a] Emissions apportioned by heat input rate. Emission rates computed for Units 1-3 on the basis of 31.5 tons/hr and for Unit 4 on the basis of 1.2 lb/10^6 Btu.

[b] Emission rates computed for Units 1-3 on the basis of 0.1 lb/10^6 Btu and for Unit 4 on the basis of 0.03 lb/10^6 Btu.

[c] Common stack for Units 1 and 2.

[d] Common stack for Units 3 and 4.

[e] Based on a maximum heat input rate of 4,692 x 10^6 Btu/hr.

Table 6-4. FDER prevention of significant deterioration maximum increment consumption ($\mu g/m^3$) at the Big Bend site[a]

Case	Annual[b]		24-hour[c]		3-hour[c]
	SO_2	TSP	SO_2	TSP	SO_2
Big Bend Units 1-4 only	0.0	0.0	-4.4	0.3	67.7
With all interacting sources					
Projected	8.0	34.3	20.3	3.7	824.1
Baseline	21.0	10.0	24.7	0.0	756.4
Increment consumption	-13.1	24.3[d]	-4.4	3.7	67.7
EPA allowable Class II increment	20	19	91	37	512

Abbreviations:

FDER = Florida Department of Environmental Regulations.
SO_2 = sulfur dioxide.
TSP = total suspended particulates.
EPA = U.S. Environmental Protection Agency.

[a] From Environmental Science and Engineering, Inc. (1979).
[b] Includes all sources within a 50-kilometer radius.
[c] Includes all sources within a 15-kilometer radius plus other major sources.
[d] Modeling violation only.

Note: Minus values indicate air quality improvement.

Table 6-5. EPA prevention of significant deterioration maximum increment consumption ($\mu g/m^3$) at the Big Bend site[a]

Case	Annual[b] SO_2	Annual[b] TSP	24-hour[c] SO_2	24-hour[c] TSP	3-hour[c] SO_2
Big Bend Units 1-4 only	0.0	0.0	-4.4	0.3	67.7
With all interacting sources	-0.1	26.6[d]	-4.4	3.7	67.7
EPA allowable Class II increment	20	19	91	37	512

Abbreviations:
EPA = U.S. Environmental Protection Agency.
SO_2 = sulfur dioxide.
TSP = total suspended particulates.

[a] From Environmental Science and Engineering, Inc. (1979).
[b] Includes all sources within a 50-kilometer radius.
[c] Includes all sources within a 15-kilometer radius plus other major sources.
[d] Modeling violation only.

Note: Minus values indicate air quality improvement.

Table 6-6. Maximum air quality impacts (μg/m^3) at the Big Bend site with Unit 4 operating[a]

Case	Annual		24-hour[b]		3-hour[b]
	SO_2	TSP	SO_2	TSP	SO_2
Attainment area impact					
Big Bend Unit 4 only	1	1	34.2	0.9	163
Big Bend Units 1-4 only	8.5	0.2	185	3.7	1,087
With all interacting sources	18.5	69.2[c]	82	128.1[d]	992
State of Florida AAQS	60	60	260	150	1,300
Nonattainment area impact[e]					
Big Bend Unit 4 only	1	1	4	0.4	17
Significance of impact levels	1	1	5	5	25

Abbreviations:
SO_2 = sulfur dioxide.
TSP = total suspended particulates.
AAQS = ambient air quality standard.

[a] From Environmental Science and Engineering, Inc. (1979).
[b] Not to be exceeded more than once per year.
[c] Includes background concentration of 35 μg/m^3. Modeling violation only.
[d] Includes background concentration of 55 μg/m^3.
[e] SO_2 impact at Pinellas County nonattainment area and TSP impact at Hillsborough County nonattainment area.

Table 6-7. Maximum air quality impacts for NO_2 and CO (μg/m^3) from Big Bend Unit 4

Pollutant	Maximum air quality impact		Level of significant impact			State of Florida AAQS		
	Annual	3-hour	8-hour	Annual	1-hour	8-hour	Annual	1-hour
NO_2	0.5	--	--	1.0	--	--	100	--
CO	--	7.8	500	--	2,000	10,000	--	40,000

Abbreviations:
NO_2 = nitrogen dioxide.
CO = carbon monoxide.
AAQS = ambient air quality standard.

Table 6-8. Worst days/periods utilized in PTMTPW computer model[a]

Regulations	Worst day/year (period)	Critical direction (degrees)	Downwind distance (km)	Comments
AAQS (incremental)	220/71	90	2.3-2.7	SO_2 + TSP 24-hour maximum impact--Big Bend Unit 4 only--100% load
AAQS (incremental)	158/73 (4)	280	1.8-2.2	SO_2 3-hour maximum impact--Big Bend Unit 4 only--100% load
AAQS, PSD (incremental)	328/71 (4)	320	At border	SO_2 3-hour maximum impact--Big Bend Unit 4 only--100% load
AAQS (incremental)	207/72	90	5.3-5.7	SO_2 + TSP 24-hour maximum impact--Big Bend Units 1-4--100% load
AAQS (incremental)	249/72 (4)	90	1.3-1.7	SO_2 3-hour maximum impact--Big Bend Units 1-4--100% load
PSD (interaction)	257/71	140	1.3-1.7	SO_2 + TSP 24-hour maximum increment consumption with interacting sources--Big Bend Units 1-4--100% load, projected and baseline
PSD (interaction)	243/74 (4)	290	1.3-1.7	SO_2 3-hour maximum increment consumption with interacting sources--projected: Units 1-4, 75% load; baseline: Units 1 and 3, 100% load
	164/74 (4)	300	1.3-1.7	SO_2 3-hour maximum increment consumption with interacting sources--Big Bend Units 1-4--50% load
AAQS (interaction)	238/73 (5)	180, 190	0.1-2.0	SO_2 24- and 3-hour maximum impact with interacting sources--Big Bend Units 1-4--50% load
	226/74 (4)	340	0.1-2.0	SO_2 24- and 3-hour maximum impact with interacting sources--Big Bend Units 1-4--50% load

Abbreviations:
km = kilometer
AAQS = ambient air quality standard.
PSD = prevention of significant deterioration.
SO_2 = sulfur dioxide.
TSP = total suspended particulates.

[a] From Environmental Science and Engineering, Inc. (1979).

Table 6-9. Applicant's drift predictions and Class II PSD increments for a mechanical-draft cooling tower with saltwater makeup[a],[b]

Particulate concentration	Drift prediction		Class II PSD increment
	Suspended	Total	
Maximum annual average	0.05	5.88	19 (annual geometric mean)
Maximum for 24 hours	4.52	76.4	37 (24-hour maximum)

Abbreviation: PSD = prevention of significant deterioration.

[a] Adapted from Stone & Webster Engineering Corporation (1979b).
[b] All values in μg/m^3.

Table 6-10. Results of drift predictions for the mechanical-draft cooling tower[a]

Parameter	Annual			Monthly			Daily			Hourly		
	Predicted value	Distance (ft)	Sector	Predicted value	Distance (ft)	Sector	Predicted value	Distance (ft)	Sector	Predicted value	Distance (ft)	Sector
Maximum salt-deposition rate (lb/acre-period)	1,270	750	NW	274.1	750	NW	NA	--	--	NA	--	--
Maximum water-deposition rate (lb/acre-period)	23,220	750	NW	NA	--	NW	NA	--	--	NA	--	--
Maximum suspended-salt concentration ($\mu g/m^3$)	0.0549	3,250	SW	NA	--	--	4.52	2,750	WSW	33.3	5,000	SE
Maximum airborne-salt concentration ($\mu g/m^3$)	5.88	750	NW	15.3	750	NW	76.4	500	SW	345	500	N

Abbreviation: NA = not available.

[a]Adapted from Stone & Webster Engineering Corporation (1979b).

Table 6-11. Summary of ORFAD salt drift modeling results, Big Bend Unit 4 mechanical-draft cooling tower[a]

Downwind direction	Maximum annual drift[b] (g/m^2)	Maximum annual average airborne salt concentration (μg/m^3)[b]
S	25.4	0.47
SSW	22.0	0.40
SW	32.9	0.59
WSW	53.6	0.95
W	83.4	1.49
WNW	46.9	0.84
NW	30.6	0.55
NNW	28.3	0.51
N	29.6	0.54
NNE	18.4	0.34
NE	15.3	0.28
ENE	18.0	0.33
E	41.4	0.77
ESE	19.0	0.35
SE	23.1	0.42
SSE	20.9	0.38

Abbreviation: ORFAD = Oak Ridge Fog and Drift.

[a] Adapted from Environmental Science and Engineering, Inc. (1980).

[b] In all instances, the maximum annual drift and the maximum annual average airborne salt concentration would occur at a distance of 0.20 kilometer.

Table 6-12. Predicted maximum monthly salt-deposition rates in nearby agricultural areas attributable to the operation of a mechanical-draft cooling tower at Big Bend Unit 4[a]

Agricultural area	Distance (ft)	Maximum monthly deposition rate (lb/acre)		
		Direction	Month	Deposition
1	3,000-4,250	E	July	4.6-2.5
2	4,250-5,500	E	July	2.5-1.5
3	4,000-6,000	SE	June	8.8-4.2
4	3,000-4,250	E	July	4.6-2.5
5	4,250-5,500	E	July	2.5-1.5

[a]Adapted from Stone & Webster Engineering Corporation (1979b).

Table 6-13. Engineering parameters input to the ORFAD model for estimating drift from a mechanical-draft cooling tower at Big Bend Unit 4[a]

Parameter	Value
Stack height above ground (m)	21.3
Temperature range (^{o}F)	17
Water-to-air mass flow ratio (g/g)	1.6
Tower top inner radius (m)	17.3
Tower exit velocity (m/s)	8.6
Total heat rejected (10^6 cal/s)	151.0
Latitude (^{o}N)	27.8
Longitude (^{o}W)	82.4
Tower base elevation above mean sea level (ft)	8.5
Fraction of water as drift (g/g)	0.0002
Concentration of dissolved solids (g/g)	0.042
Number of cooling towers	1
Cooling towers per cluster	1
Maximum cluster dimension (m)	80.8

Abbreviation: ORFAD = Oak Ridge Fog and Drift.

[a]Stone & Webster Engineering Corporation (1980); adapted from Environmental Science and Engineering, Inc. (1980).

Table 6-14. Continuous discharge stream water quality[a,b]

Parameter	Intake cooling-water concentration[c]			City water[d]	Boiler blowdown	Bottom-ash blowdown[e]	FGD system blowdown[f]	Combined effluents[g]	Florida Class III standard
	Average	Minimum	Maximum						
Flow (gpm)	241,000				30	80	70 (max.)	241,180	
Alkalinity	154.2	102	300	168					
Total solids	25,199	23,550	26,580	500	10	500 (min.)	91,300		
Total suspended solids	24.2	16.3	44.3	20	4	30	30		
Nitrate nitrogen	0.05	<0.05	0.05	<0.05		<0.05	<0.05		
Phosphorus	2.5	0.90	3.3	<0.1		<0.01	<0.10		
Sulfate	1,892	1,850	1,965	44		44	55,700	1,980	
Phosphate	0.768	0.667	0.922						
Organic phosphorus	0.169	0.005	0.206						0.001[h]
Ammonia	0.07	0.04	0.08		2				
Nitrite	0.005	0.005	0.006						
Nitrate	0.023	0.005	0.046						
Bromide	1.52	0.071	2.98	0.48		0.48	0.48	2.9781	Bromine, 0.1; bromates, 100
Chlorine								0.2 FAC	0.01 TRC
Chloride	12,774	8,326	19,813	23		23	26,200	19,806	Max. 10% above background
Fluoride	2.0	1.2	5.3	0.5		0.50	0.50	5.2964	5.0
Aluminum	0.22	<0.1	0.38						1.5
Antimony	0.50	<0.2	0.80			(i)			0.2
Arsenic	0.204	0.124	0.293		0.193	0.02	0.250	0.2929	0.05
Beryllium	0.012	<0.005	0.019		<0.005	(i)	<0.02	0.0190	
Cadmium	0.001	0.001	0.001		0.005	(i)	0.01	0.0010	0.005
Calcium	276	116	330	70		70	0	330	
Chromium	0.022	0.006	0.045	<0.05	0.065	0.01	0.03	0.0450	(j)
Copper	0.008	0.004	0.013	<0.05	1[k]	0.003	0.06	0.0132	0.015
Iron	0.05	0.01	0.08	0.05	1[k]	0.71	0.05	0.0806	0.3
pH	7.3-8.5	7.3	8.5	7.8	8.5-9.0	8.4	6.5-7.0	8.0	6.5-8.5
Lead	0.01	0.01	0.01		<0.1	0.005	0.05	0.0100	0.05
Magnesium	407	122	905	28			2,300	911	
Manganese	0.02	0.01	0.04	0.05		0.24	0.06	0.0400	
Mercury	0.0001	0.0001	0.0002		0.007	(i)	<0.0002	0.0002	0.0001
Nickel	0.005	0.004	0.01	0.05	0.096	0.02	0.03	0.0101	0.1
Selenium	0.281	0.129	0.565		0.032	(i)	0.009	0.5646	0.025
Potassium	278	204	301	2.1			2.1		
Sodium	7,150	4,550	7,600	15			2,200	7,595	
Thallium	0.15	<0.1	0.2			(i)	0.15		
Zinc	0.008	0.007	0.011	2.0	0.05	0.05	0.240	0.0126	1.0
Oil and grease	1.5	<1.0	1.9	<1	5	15	20	1.9093	5
Vanadium				<0.001			<0.001		
Silver						(i)			0.00005
Sulfite							4,800	1.17	

Abbreviations:

FGD = flue-gas desulfurization.
WQ = water quality.
gpm = gallons per minute.
FAC = Florida Administrative Code.
TRC = total residual chlorine.

[a] Adapted from Tampa Electric Company (1981c).

[b] All concentrations in milligrams per liter unless otherwise indicated.

[c] Data were obtained from the following four sources, as noted in the U.S. Environmental Protection Agency NPDES permit application:

1. Water quality data for the period April 29, 1973, through May 5, 1973, Stone & Webster Engineering Corporation.
2. Water quality data for the period October 15, 1979, through December 3, 1979, Tampa Electric Company Central Testing Laboratory.
3. Water Quality data for June 26, 1979, Thorton Laboratories, Inc.
4. 316 Demonstration - BB4, Fine Mesh Screen Study Report, Tampa Electric Company (1980d).

[d] Analytical results for city water taken at Sample Point 13 on April 29, 1973 (24-hour composite values).

[e] Values reflect effluent concentrations from bottom-ash pond at plant burning southern Illinois coal. Treatability of Ash Settling Pond Effluents, Utility Water Act Group (1979).

[f] Values reflect estimated concentrations after treatment. Values estimated for "combined effluent" concentrations are based on before-treatment concentrations for conservative estimates.

[g] Combined effluents were calculated from maximum intake-water concentrations.

[h] Standard for elemental phosphorus.

[i] Less than minimum quantifiable concentration from Treatability of Ash Settling Pond Effluents, Utility Water Act Group (1979).

[j] The chromium standard is 1.0 mg/ℓ total and 0.05 mg/ℓ after reasonable mixing of discharge in receiving water.

[k] Maximum value. Estimated values are 0.04 mg/ℓ for copper and 0.001 mg/ℓ for iron.

Table 6-15. Big Bend Station intake-water-quality data for three sampling periods[a,b]

	Sampling data												
	1970-1974				1980				1980-1981				
Element	Min.	Max.	Avg.	Number of samples	Min.	Max.	Avg.	Number of samples	Min.	Max.	Avg.	Number of samples	Florida water-quality standard
Arsenic	—	—	—	—	0.124[c]	0.293[c]	0.204[c]	3	0.002	0.232	0.048	47	0.05
Cadmium	0.005	0.110	0.033	10	0.001	0.001	0.001	12	0.005	0.055	0.008	47	0.005
Chromium	0.001	0.430	0.054	15	0.006	0.045	0.022	12	0.05	0.075	0.052	47	0.05
Copper	0.0001	0.1	0.026	15	0.004	0.013	0.008	12	0.044	0.098	0.064	47	0.015
Iron	0.002	0.9	0.168	15	0.01	0.08	0.05	12	0.03	1.014	0.237	47	0.3
Lead	0.001	0.3	0.068	5	0.01	0.01	0.01	12	0.1	0.1	0.1	47	0.05
Mercury	0.00008	0.003	0.0012	5	0.0001	0.0002	0.0001	12	0.002	0.054	0.0065	47	0.0001
Nickel	0.001	0.62	0.1	15	0.004	0.01	0.005	12	0.04	0.18	0.05	47	0.1
Selenium	—	—	—	—	0.129[c]	0.565[c]	0.281[c]	3	0.004	0.112	0.036	47	0.025
Zinc	0.001	0.35	0.038	14	0.007	0.011	0.008	12	0.005	0.302	0.117	47	1.0

[a] Adapted from Tampa Electric Company (1981b).

[b] All data in mg/ℓ.

[c] October-December 1979 water-quality data.

Table 6-16. Big Bend Station intake-water-quality data, 1980-1981[a]

Element	Minimum value is above FWQS	Average value is above FWQS	Maximum value is above FWQS
Arsenic			X
Cadmium		X	X
Chromium		X	X
Copper	X	X	X
Iron			X
Lead	X[b]	X[b]	X[b]
Mercury	X	X	X
Nickel			X
Selenium		X	X
Zinc			

Abbreviation: FWQS = Federal water-quality standard.

[a] Adapted from Tampa Electric Company (1981b).
[b] Limit of detection was greater than FWQS.

Table 6-17. Big Bend Unit 4 discharge-water quality following treatment to meet State and Federal effluent limitations^{a,b}

Element	Boiler blowdown^{c}	FGD blowdown	Bottom-ash blowdown	Intake circulating water (maximum)^{d}	Detectable effluent water quality at combined discharge	Florida water-quality standard
Arsenic	0.193	0.250	0.02	0.232	0.232	0.05
Cadmium	<0.005	0.01	<0.005	0.055	0.055	0.005
Chromium	0.065	0.03	0.01	0.075	0.075	0.05
Copper	1	0.06	0.003	0.098	0.098	0.015
Iron	1	0.05	0.71	1.014	1.014	0.3
Lead	<0.1	0.05	0.005	0.1	0.1	0.05
Mercury	0.007	<0.0002	<0.0002	0.0540	0.0540	0.0001
Nickel	0.096	0.03	0.02	0.180	0.180	0.1
Selenium	0.032	0.009	<0.004	0.112	0.112	0.025
Zinc	0.05	0.24	0.05	0.302	0.302	1.0

[a] Adapted from Tampa Electric Company (1981b).

[b] All data in mg/ℓ.

[c] No treatment required to meet effluent standards.

[d] From 1981 data.

Table 6-18. Big Bend Unit 4 discharge-water quality following treatment to meet State and Federal effluent limitations and reverse-osmosis treatment of the blowdown streams[a],[b]

Element	Combined blowdown streams after heavy-metal treatment	Intake circulating water (maximum)[c]	Combined detectable water quality at discharge (heavy-metal removal)	Combined detectable water quality at discharge (no heavy-metal removal)	Florida water-quality standard
Arsenic	0.05	0.232	0.232	0.232	0.05
Cadmium	0.005	0.055	0.055	0.055	0.005
Chromium	0.045	0.075	0.075	0.075	0.05
Copper	0.015	0.098	0.098	0.098	0.015
Iron	0.3	1.014	1.014	1.014	0.3
Lead	0.038	0.1	0.1	0.1	0.05
Mercury	0.0001	0.054	0.054	0.054	0.0001
Nickel	0.037	0.180	0.180	0.180	0.1
Selenium	0.011	0.112	0.112	0.112	0.025
Zinc	0.012	0.302	0.302	0.302	1.0

[a] From Tampa Electric Company (1981b).
[b] All data in mg/ℓ.
[c] From 1981 data.

Table 6-19. Dilution factors calculated for chlorine discharged from Big Bend Unit 4[a]

Effective dilution factor	Distance (feet)	Area[b]	
		Square feet	Acres
2	190.8	46,934.8	1.1
3	302.4	74,389.9	1.7
4	381.6	93,869.6	2.2
5	443.0	108,979.3	2.5
6	493.2	121,324.8	2.8
7	535.6	131,762.7	3.0
8	572.4	140,804.5	3.2
9	604.8	148,779.9	3.4
10	633.8	155,914.1	3.6
11	660.0	162,367.8	3.7
12	684.0	168,259.6	3.9
13	706.0	173,679.5	4.0
14	726.4	178,697.5	4.1
15	745.4	183,369.2	4.2
16	753.2	187,739.3	4.3
17	779.9	191,844.3	4.4
18	795.6	195,714.7	4.5
19	810.5	199,375.7	4.6
20	824.6	202,848.9	4.7

[a] Adapted from Tampa Electric Company (1980b).

[b] Based on a channel width of 246 feet.

Table 6-20. Tolerance of selected species to continuously chlorinated effluent[a]

Species	Life form	96-hour LC_{50} (mg/ℓ)	Reference
Crassostrea virginica (Ostreidae) Eastern oyster	Juvenile	0.023	Roberts et al. (1975)
	Juvenile	>1.500	Bongers et al. (1977)
Callinectes sapidus (Portunidae) Blue crab		0.1	Mattice and Zittel (1976)
Brevoortia tyrannus (Clupeidae) Atlantic menhaden	Juvenile	$0.09 < LC_{50} < 0.223$	Bongers et al. (1977)
Leiostomus xanthurus (Sciaenidae) Spot	Juvenile	$0.09 < LC_{50} < 0.223$	Bongers et al. (1977)
Menidia menidia (Atherinidae) Atlantic silverside	Larvae/ juvenile	0.037	Roberts et al. (1975)

Abbreviations:

LC_{50} = concentration lethal to 50 percent of the test organisms after 96 hours.

mg/ℓ = milligrams per liter.

[a] Adapted from Tampa Electric Company (1981c).

Table 6-21. Flow, velocity, and temperature characteristics of the condenser-cooling-water systems for Big Bend Units 1-4

Parameter	Unit 1	Unit 2	Unit 3	Unit 4
Intake channel				
Unit flow, cfs	537	537	537	537
Cumulative flow, cfs	2,148	1,611	1,074	537
Velocity, fps	0.56	0.42	0.28	0.14
Discharge channel				
Maximum temperature rise, °F	16.8	16.8	16.8	16.8
Avgerage temperature rise, °F	11.0	11.0	11.0	11.0

Abbreviations:

cfs = cubic feet per second.

fps = feet per second.

Table 6-22. Water surface areas enclosed by ΔT isotherms during the combined operation of three Big Bend units without dilution pumps

ΔT (°C)	Area (ha)	
	100% load	64% load
1	1,408	923
2	692	437
3	409	219
4	190	109
5	97	55
6	55	31
7	32	19
8	20	11
9	11	6

Table 6-23. Water surface areas swept over tidal cycle by ΔT isotherms during the combined operation of three Big Bend units without dilution pumps

ΔT (°C)	Area (ha)	
	100% load	64% load
1	1,854	1,408
2	923	761
3	875	397
4	356	182
5	178	89
6	91	49
7	51	25
8	26	12
9	15	6
10	7	--

Table 6-24. Bottom contact data for thermal plume during the combined operation of three Big Bend units without dilution pumps

Station load (%)	ΔT (°C)	Distance to isotherm (m)	Area enclosed by isotherm (ha)
100	9.8	361	7
64	9.4	301	5

Table 6-25. Water surface areas enclosed by ΔT isotherms during the combined operation of four Big Bend units without dilution pumps

ΔT (°C)	Area (ha) 100% load	 64% load
1	1,449	1,166
2	720	559
3	457	324
4	291	154
5	150	77
6	77	43
7	43	24
8	25	15
9	15	10
10	9	--

Table 6-26. Water surface areas swept over tidal cycle by ΔT isotherms during the combined operation of four Big Bend units without dilution pumps

ΔT (°C)	Area (ha) 100% load	 64% load
1	2,015	1,610
2	983	882
3	607	526
4	389	283
5	231	134
6	130	69
7	71	37
8	43	34
9	20	10
10	10	--

Table 6-27. Bottom contact data for thermal plume during the combined operation of four Big Bend units without dilution pumps

Station load (%)	ΔT (°C)	Distance to isotherm (m)	Area enclosed by isotherm (ha)
100	10.1 (bottom detachment)	392	8
64	9.7 (bottom detachment)	331	6

Table 6-28. Temperature of the effluent from Unit 4 at the outfall and of seasonal ambient water for the once-through cooling alternative[a]

Season/month	Ambient water temperature[b] (°F)			Discharge water temperature (°F)		
	Maximum	Minimum	Average	Maximum	Minimum	Average
Winter						
January	66	54	59.6	83	71	76.6
February	63	50	57.9	80	67	74.9
Summer						
March	75	58	66.4	82	75	83.4
April	85	67	76.8	102	84	93.8
May	85	73	80.0	102	90	97.0
June	89	81	85.6	106	98	102.6
July	94	82	87.2	111	99	104.2
August	90	79	86.1	107	96	103.1
September	88	82	85.4	105	99	102.4
October	84	71	76.9	101	88	93.9
Winter						
November	79	67	73.4	96	84	90.4
December	77	62	68.7	94	79	85.7

[a] Adapted from Tampa Electric Company (1981a).
[b] Intake cooling-water data for 1978.

Table 6-29. Comparison of cooling-tower intake and discharge concentrations for potential sources of makeup water for Big Bend Unit 4[a],[b]

Parameter	Bay water				Ground water[c]				Tampa sewage treatment plant effluent			
	Intake		Discharge		Intake		Discharge		Intake		Discharge	
	average	Average	Minimum	Maximum	average	Average	Minimum	Maximum	average	Averag?	Minimum	Maximum
pH	7.3-8.5	NA	7.3	8.5	7.4-8.2	NA	7.4	8.2	6.9-7.1	NA	6.9	7.1
Total suspended solids	24.2	36.3	24.5	66.5	ND	ND	ND	ND	11.5	17.3	ND	ND
Aluminum	0.22	0.33	0.15	0.57	ND	ND	ND	ND	ND	ND	ND	ND
Arsenic	0.20	0.31	0.19	0.44	ND	ND	ND	ND	0.003	0.005	ND	ND
Cadmium	0.028	0.042	0.008	0.113	ND	ND	ND	ND	0.001	0.002	ND	ND
Chromium	0.022	0.033	0.009	0.068	0.02	0.03	ND	ND	0.012	0.018	ND	ND
Copper	0.008	0.012	0.006	0.02	0.01	0.015	ND	ND	0.002	0.003	ND	ND
Lead	0.01	0.02	0.02	0.02	ND	ND	ND	ND	0.03	0.05	ND	ND
Mercury	0.0001	0.0002	0.0002	0.0003	ND	ND	ND	ND	0.0051	0.0077	ND	ND
Nickel	0.005	0.008	0.006	0.02	ND	ND	ND	ND	0.023	0.035	ND	ND
Zinc	0.008	0.012	0.011	0.017	0.26	0.39	ND	ND	0.04	0.06	ND	ND
Oil and grease	1.5	2.3	1.0	2.9	ND	ND	ND	ND	ND	ND	ND	ND
Chlorine[d]	NA	0.2	0.01	0.5	NA	0.2	0.03	0.5	NA	0.2	0.03	0.5
Selenium	0.28	0.42	0.19	0.85	ND	ND	ND	ND	ND	ND	ND	ND
Beryllium	0.012	0.018	0.008	0.029	ND	ND	ND	ND	ND	ND	ND	ND

Abbreviations:

NA = not applicable.
ND = no data.

[a] Adapted from Tampa Electric Company (1981a).

[b] All except pH values in milligrams per liter.

[c] Data from Wilson (1977) and Wilson et al. (1973).

[d] Total residual chlorine.

Table 6-30. Comparison of water temperatures in cooling-tower intake and blowdown discharge, Big Bend Unit 4[a]

Season and month	Ambient water temperature (°F)			Blowdown discharge temperature (°F)		
	Maximum	Minimum	Average	Maximum	Minimum	Average
Winter						
January	66	54	59.6	80.4	56.5	69.3
February	63	50	57.9	80.9	57.5	69.4
Summer						
March	75	58	66.4	84.0	60.0	72.3
April	85	67	76.8	89.5	63.5	75.3
May	85	73	80.0	93.9	67.5	79.9
June	89	81	85.6	96.5	73.4	85.5
July	94	82	87.2	97.4	76.4	87.3
August	90	79	86.1	98.4	77.5	88.3
September	88	82	85.4	96.5	75.1	85.5
October	84	71	76.9	92.0	68.5	79.5
Winter						
November	79	67	73.4	85.1	60.8	73.4
December	77	62	68.7	81.2	57.1	70.0

[a] Adapted from Tampa Electric Company (1981a).

Table 6-31. Water quality of site ground water and suggested EPA standards[a]

Parameter	Surficial aquifer at site, March 1976[b] West well	East well	South well	North well	Floridan aquifer[c] 1953	1974	EPA standard[d]
Phosphate, total	4.13	3.15	3.6	3.43			
Silica	47.9	45.4	14.8	44.2	21	28	
Calcium	692	155	176	1116	170	170	
Magnesium	173	51	53	384	65	52	
Sodium	10,000	18	17	300		50	
Potassium	1.9	0.5	1.6	1.4		3.1	
Iron, total	1.46	0.64	0.66	0.81	0.28	0.10	
Iron, dissolved	0.2	0.14	0.40	0.36			
Nickel	0.0	0.0	0.0	0.0			
Copper	0.01	0.01	0.01	0.01			1.0
Cadmium[e]	0.01		0.1	<0.01			0.01
Chromium	6.6	9.9	5.0	7.9			0.05
Lead[e]	<0.05		<0.05	<0.05			0.05
Mercury[e]	<0.002		<0.002	<0.002			
Selenium[e]	<0.5		<0.5	<0.5			0.01
Zinc	0.45	0.25	0.17	0.68			6.0
Manganese	0.12	0.18	0.18	0.24			0.05
Vanadium[e]	<1		<1	<1			
Sulfate	93.2	102.8	82.7	180.7	510	450	250
Chloride	2570	35	59	3317	88	100	250
Bicarbonate					172	173	
Nitrogen	0.56	0.89	0.22	0.78			
Nitrates	2.6	4.6	2.2	3.75			45
Arsenic[e]	0.28		0.05	0.06			
Bromine	8.6	0.1	0	12.5			
Phosphorus	0.04	0.22	0.2	0.08	0.4	0.6	
Biological oxygen demand	0	0	0	0			
Total dissolved solids	3641	4789	627	4329	1080	1000	500
Total suspended solids	50	35	14	59			
pH	7.00	6.96	8.35	6.4	7.3	7.3	
Oil and grease	0	0	0	0			
Turbidity (Ftu)	28	24	32	40			

Abbreviations:
EPA = U.S. Environmental Protection Agency.
Ftu = Formazin turbidity units.

[a] From Tampa Electric Company (1980b).
[b] Environmental Associates, Inc., analyses dated March 10, 1976.
[c] Duerr (1979).
[d] EPA standards for drinking water, primary and secondary.
[e] Interscience Associates, Inc., analyses dated December 15, 1975.

Table 6-32. Data on water quality of effluents produced at four different bottom-ash disposal areas[a,b]

Component	Effluents[d]				Avg. A+B+C+D	EPA standard[e]	FDER[c] ground-water quality standard
	A	B	C	D			
Iron, total	0.90	0.91	0.98	0.71	0.88		
Iron, dissolved	0.03	0.06	0.05	0.03	0.043		
Nickel	0.009	0.02	0.03	0.02	0.02		
Copper	(f)	0.008	0.03	0.004	0.014		
Cadmium	0.001	(f)	(f)	(f)	0.001	0.01	0.01
Chromium	(f)	(f)	(f)	0.006	0.006	0.05	0.05
Lead	(f)	(f)	(f)	(f)		0.05	0.05
Mercury	(f)	(f)	(f)	(f)		0.002	0.002
Selenium	(f)	(f)	(f)	(f)		0.01	0.01
Zinc	0.007	0.13	0.03	0.01	0.044		
Manganese	0.10	0.29	0.15	0.01	0.138		
Arsenic	(f)	(f)	(f)	0.01	0.01	0.05	0.05
Antimony	(f)	(f)	(f)	(f)			
Beryllium	(f)	(f)	(f)	(f)			
Silver	(f)	(f)	(f)	(f)		0.05	
Titanium	(f)	(f)	(f)	(f)			
Total dissolved solids							
Total suspended solids		4.6	7.7	55.6			
pH	7.8	6.8	7.8	8.4			

Abbreviations:

EPA = U.S. Environmental Protection Agency.

FDER = Florida Department of Environmental Regulation.

[a] From Tampa Electric Company (1981c).

[b] Values are in milligrams per liter and were obtained from Utility Water Act Group (1979).

[c] Florida Administrative Code, Chapter 17-3.101.

[d] The following letters identify the coal type for each pond from which the samples were taken:

A. Western West Virginia coal
B. Eastern Ohio coal
C. Southern Ohio coal
D. Southern Illinois coal

These effluents were used to provide conservative estimates of leachate quality.

[e] National interim primary drinking water standards.

[f] Values less than the minimum quantifiable concentration from Utility Water Act Group (1979).

Table 6-33. Numbers of fish and macroinvertebrates impinged in 24 hours on the traveling screens of the condenser cooling system at one generating unit of Big Bend Station, January 1976 to March 1977[a,b]

Taxon	1976								1977	
	January-March (6/91)[c]		April-June (7/91)[c]		July-September (6/92)[c]		October-December (7/92)[c]		January-March (5/90)[c]	
	Total number collected during impingement sampling	Impingement rate per day[d]	Total number collected during impingement sampling	Impingement rate per day[d]	Total number collected during impingement sampling	Impingement rate per day[d]	Total number collected during impingement sampling	Impingement rate per day[d]	Total number collected during impingement sampling	Impingement rate per day[d]
Total fishes	328	54.7	1,362	194.6	2,704	450.7	1,404	200.6	3,996	793.2
Anchoa mitchilli Bay anchovy	35	5.8	64	9.1	33	5.5	733	104.7	2,956	591.2
Bairdiella chrysoura Silver perch	29	4.8	576	82.3	2,093	348.8	149	21.3	250	50.0
Lagodon rhomboides Pinfish	24	4.0	181	25.9	91	15.2	19	2.7	191	38.2
Cynoscion arenarius Sand seatrout	16	2.7	202	28.9	57	9.5	83	11.9	53	10.6
Prionotus scitulus Leopard searobin	25	4.2	62	8.9	13	2.2	61	8.7	140	28.0
Chloroscombrus chrysurus Atlantic bumper	3	0.5	3	0.4	79	13.2	168	24.0	49	9.8
Other fishes	196	32.7	274	39.1	338	56.3	191	27.3	327	65.4
Total macroinvertebrates	2,458	409.7	1,073	153.3	2,612	435.3	1,244	177.7	2,314	462.8
Penaeus duorarum Pink shrimp	944	157.3	382	54.6	1,923	320.5	246	35.1	289	57.8
Callinectes sapidus Blue crab	495	82.5	20	2.9	3	0.5	119	17.0	619	123.8
Limulus polyphemus Horseshoe crab	549	91.5	104	14.9	94	15.7	104	14.9	371	74.2
Portunus gibbesi	145	24.2	66	9.4	54	9.0	267	38.1	346	69.2
Lolliguncula brevis Brief squid	76	12.7	197	28.1	318	53.0	82	11.7	53	10.6
Squilla empusa	77	12.8	21	3.0	0	0	157	22.4	311	62.2
Other macroinvertebrates	172	28.7	283	40.4	220	36.7	269	38.4	325	65.0

[a] Adapted from Peekstok, Page, and Haynes (1977).
[b] Sampling conducted at intervals of approximately 2 weeks at Unit 1 or 2.
[c] Numbers in parentheses are the ratio of sampling days to the total number of days in the 3-month period.
[d] Total number collected during impingement sampling divided by the number of impingement sampling days.

Table 6-34. Estimates of the number of fish and macroinvertebrates impinged on the traveling screens of the condenser cooling systems during the continuous operation of Big Bend Units 1, 2, and 3 from January 1976 to March 1977[a,b]

Taxon	1976				1977	Annual	
	January-March (89.7)[c]	April-June (156.5)[c]	July-September (236.1)[c]	October-December (241.7)[c]	January-March (212.6)[c]	January-December 1976 (724.0)[c]	April 1976-March 1977 (846.9)[c]
Total fishes	4,906	30,455	106,428	48,489	168,650	190,278	354,022
Anchoa mitchilli Bay anchovy	520	1,424	1,299	25,308	125,701	28,551	153,732
Bairdiella chrysoura Silver perch	431	12,880	82,366	5,149	10,631	100,826	111,026
Lagodon rhomboides Pinfish	359	4,053	3,589	653	8,122	8,654	16,417
Cynoscion arenarius Sand seatrout	242	4,523	2,243	2,876	2,254	9,884	11,896
Prionotus scitulus Leopard searobin	377	1,393	520	2,103	5,953	4,393	9,969
Chloroscombrus chrysurus Atlantic bumper	45	63	3,117	5,801	2,084	9,026	11,065
Other fishes	2,932	6,119	13,294	6,599	13,905	28,944	39,917
Total macroinvertebrates	36,746	23,991	102,792	42,954	98,401	206,483	268,138
Penaeus duorarum Pink shrimp	14,108	8,545	75,683	8,484	12,289	106,820	105,001
Callinectes sapidus Blue crab	7,399	454	118	4,109	26,322	12,080	31,003
Limulus polyphemus Horseshoe crab	8,207	2,332	3,707	3,602	15,776	17,848	25,417
Portunus gibbesi	2,170	1,471	2,125	9,210	14,713	14,976	27,519
Lolliguncula brevis Brief squid	1,139	4,398	12,515	2,828	2,254	20,880	21,995
Squilla empusa	1,148	470	0	5,415	13,225	7,033	19,110
Other macroinvertebrates	2,575	6,321	8,644	9,306	13,822	26,846	38,093

[a] Adapted from Peekstok, Page, and Haynes (1977).

[b] Estimates calculated by multiplying daily impingement rates by the number of days within the quarterly or annual period and by the total number of generating units (three) operating at the plant site during 1976-1977.

[c] Total number of unit-days that Units 1, 2, and/or 3 were in operation.

Table 6-35. List of all representative important species collected from the traveling screens at Big Bend Station between March 14, 1979, and February 12, 1980 (Sheet 1 of 2)

Species	March 14, 1979				March 27, 1979				April 10, 1979				April 24, 1979				May 10, 1979				May 25, 1979			
Station	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6
Penaeus duorarum	2	--	1	2	5	3	9	8	--	--	7	10	--	1	18	12	4	--	2	6	1	--	--	2
Callinectes sapidus	2	3	3	6	2	1	3	1	--	--	2	2	1	--	--	1	--	1	1	2	--	--	--	1
Menippe mercenaria	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--
Harengula jaguana	--	--	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anchoa mitchilli	--	1	1	2	1	1	10	5	--	1	--	--	--	--	--	--	--	2	1	--	--	--	--	--
Bairdiella chrysoura	--	--	1	--	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	1	20	6	38	43
Cynoscion nebulosus	--	1	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pogonias cromis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	4	5	6	11	9	6	23	15	--	1	9	12	1	1	18	13	4	3	5	9	21	6	38	46

Species	June 19, 1979				July 3, 1979				July 17, 1979				July 31, 1979				August 14, 1979				August 28, 1979			
Penaeus duorarum	--	--	--	2	--	--	51	56	14	2	30	11	77	15	57	40	39	5	74	29	57	3	73	36
Callinectes sapidus	1	1	--	1	1	--	2	5	1	--	2	--	--	--	--	--	--	--	--	--	--	--	--	1
Menippe mercenaria	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Harengula jaguana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anchoa mitchilli	2	3	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	1	--	--	--	--	--	--
Bairdiella chrysoura	18	4	81	19	4	--	46	16	2	1	2	1	--	1	--	1	5	1	3	4	1	1	1	4
Cynoscion nebulosus	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pogonias cromis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	21	8	83	22	5	1	99	78	17	3	34	12	77	16	57	41	44	7	77	33	58	4	74	41

Note: See note at end of table.

Table 6-35. List of all representative important species collected from the traveling screens at Big Bend Station between March 14, 1979, and February 12, 1980 (Sheet 2 of 2)

Species	September 11, 1979				September 25, 1979				October 9, 1979				October 23, 1979				November 9, 1979				November 20, 1979			
Station	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6
Penaeus duorarum	34	4	242	64	19	5	62	41	86	11	67	45	12	--	13	21	4	8	--	30	15	9	44	40
Callinectes sapidus	--	--	1	2	--	--	1	--	--	--	--	--	--	--	--	1	--	--	--	--	2	--	1	--
Menippe mercenaria	--	--	1	--	--	--	1	--	--	--	--	--	--	--	--	2	1	--	1	--	1	--	--	--
Harengula jaguana	1	--	--	--	--	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anchoa mitchilli	--	1	2	--	--	1	1	--	2	--	8	1	2	--	4	4	--	--	--	--	--	5	9	--
Bairdiella chrysoura	3	5	5	8	--	--	3	4	5	--	--	4	1	--	1	2	--	--	1	--	1	--	3	2
Cynoscion nebulosus	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pogonias cromis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	38	11	251	74	19	6	68	45	95	11	75	50	15	--	16	30	5	8	2	30	19	14	57	42

Species	December 6, 1979				December 18, 1979				January 1, 1980				January 15, 1980				January 29, 1980				February 12, 1980			
Station	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6	12	18	24	6
Penaeus duorarum	18	7	11	14	2	1	9	3	1	2	9	4	--	2	--	1	2	2	2	1	4	1	--	2
Callinectes sapidus	4	1	3	8	1	--	2	2	2	3	6	23	--	--	7	6	9	1	7	19	27	8	28	24
Menippe mercenaria	--	--	--	--	2	--	2	--	--	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--
Harengula jaguana	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Anchoa mitchilli	33	9	19	11	1	--	3	2	4	3	6	9	--	--	--	--	--	1	--	1	2	--	2	2
Bairdiella chrysoura	8	4	15	8	--	2	12	1	--	2	2	--	--	--	1	--	--	--	--	--	1	--	--	--
Cynoscion nebulosus	--	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pogonias cromis	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total	63	22	48	41	6	3	28	8	7	10	24	36	--	2	8	7	11	4	9	21	34	9	30	28

Note: The total for the sampling period covered before is 2,570. The totals for each species are as follows: P. duorarum, 1,738; C. sapidus, 199; M. mercenaria, 14; H. jaguana, 4; A. mitchilli, 181; B. chrysoura, 431; Cynoscion nebulosus, 4; Pogonias cromis, 1.

Table 6-36. Projections of the number of RIS fish and macroinvertebrate taxa impinged annually on the cooling-water traveling screens of Big Bend Units 1-3 and Units 1-4[a]

Taxon	Projected annual impingement for Units 1-3[b]	Projected annual impingement for Units 1-4[c]
Macroinvertebrates		
Penaeus duorarum Pink shrimp	73,500	98,360
Callinectes sapidus Blue crab	12,750	17,064
Menippe mercenaria Stone crab	600	786
Fishes		
Anchoa mitchilli Bay anchovy	8,250	10,630
Harengula jaguana Scaled sardine	165	220
Menidia beryllina Tidewater silverside	NI	NI
Bairdiella chrysoura Silver perch	21,750	29,444
Cynoscion nebulosus Spotted seatrout	213	284
Pogonias cromis Black drum	42	56

Abbreviations: RIS = representative important species.
NI = no information; not collected during 1979-1980 impingement studies.

[a] Projections based on impingement collections made at intervals of approximately 2 weeks from March 14, 1979, to February 12, 1980.

[b] Interpolated from projections for Units 1-4.

[c] Reported in Tampa Electric Company (1980c).

Table 6-37. Monthly RIS impingement estimates for four Big Bend units at 100 percent flow capacity

Species	1979										1980		
	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Total
Penaeus duorarum	1,512	2,702	1,294	2,796	12,588	21,688	27,480	14,100	8,556	4,008	920	716	98,360
Callinectes sapidus	3,282	450	314	408	436	60	204	62	512	1,786	3,410	6,140	17,064
Menippe mercenaria	0	14	48	24	32	8	88	144	146	246	36	0	786
Harengula jaguana	72	36	0	0	0	8	60	44	0	0	0	0	220
Anchoa mitchilli	986	394	242	420	30	78	356	976	2,384	3,516	732	516	10,630
Menidia beryllina	0	0	0	0	0	0	0	0	0	0	0	0	0
Bairdiella chrysoura	150	50	6,464	12,756	3,022	1,174	1,536	710	1,148	2,142	202	90	29,444
Cynoscion nebulosus	104	0	0	0	0	8	48	0	22	34	0	68	284
Pogonias cromis	0	0	0	24	32	0	0	0	0	0	0	0	56

Table 6-38. Operational data on condenser cooling water and dilution pumps for Big Bend Units 1-3, January 1976-March 1977[a]

Month	Condenser cooling-water pumps Unit 1	Unit 2	Unit 3	Total of all three units	Dilution pump
1976					
January	2.00	29.16	(b)	31.16	6.83
February	0.00	27.58	(b)	27.58	0.00
March	0.44	30.51	(b)	30.95	15.33
April	12.28	29.75	(b)	42.03	27.00
May	30.11	5.00	22.54	57.65	28.50
June	28.70	0.00	28.12	56.85	23.00
July	30.24	21.95	26.83	79.02	31.00
August	27.62	29.47	18.57	75.66	28.00
September	25.26	27.51	28.69	81.46	20.83
October	29.89	30.88	25.45	86.22	31.00
November	24.45	24.25	18.33	67.03	15.33
December	28.62	30.87	28.98	88.47	31.00
Total	239.61	286.93	197.51	724.05	257.82
1977					
January	29.41	25.95	27.73	83.09	27.83
February	27.69	25.93	15.04	68.66	22.83
March	30.20	30.67	0.00	60.87	26.83

[a] All values are days of operation.
[b] Not in service.

Table 6-39. Estimated number of total fish eggs and larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Eggs		Larvae	
	Condenser entrainment	Dilution pump entrainment	Condenser entrainment	Dilution pump entrainment
1976				
January	0	0	2.217×10^{6}	5.940×10^{5}
February	3.069×10^{7}	0	3.022×10^{6}	0
March	2.709×10^{8}	1.817×10^{10}	5.342×10^{7}	1.873×10^{9}
April	3.996×10^{10}	3.395×10^{10}	5.234×10^{9}	3.458×10^{9}
May	3.295×10^{10}	3.246×10^{10}	4.476×10^{9}	2.502×10^{9}
June	7.092×10^{9}	8.126×10^{9}	1.161×10^{9}	5.926×10^{8}
July	4.442×10^{9}	7.029×10^{9}	4.764×10^{9}	3.197×10^{9}
August	6.052×10^{8}	3.599×10^{8}	6.290×10^{9}	6.325×10^{8}
September	2.803×10^{8}	6.689×10^{7}	3.434×10^{9}	2.939×10^{8}
October	4.592×10^{7}	0	6.191×10^{8}	3.266×10^{7}
November	9.646×10^{5}	8.172×10^{4}	1.312×10^{7}	6.136×10^{6}
December	2.994×10^{5}	1.532×10^{4}	1.871×10^{6}	2.007×10^{6}
Total	8.568×10^{10}	1.002×10^{11}	2.596×10^{10}	1.259×10^{10}
1977				
January	0	3.581×10^{4}	2.437×10^{6}	2.937×10^{6}
February	1.648×10^{6}	4.110×10^{6}	6.914×10^{6}	4.829×10^{6}
March	1.368×10^{10}	6.925×10^{9}	1.087×10^{9}	2.756×10^{8}
Total April 1976-March 1977	9.906×10^{10}	8.892×10^{10}	2.709×10^{10}	1.100×10^{10}

[a] Adapted from Phillips et al. (1977).

Table 6-40. Estimated number of total invertebrate meroplankton entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Condenser entrainment	Dilution pump entrainment
1976		
January	5.014×10^{7}	8.178×10^{6}
February	1.119×10^{9}	0
March	9.379×10^{9}	4.843×10^{10}
April	7.191×10^{10}	8.859×10^{10}
May	8.461×10^{10}	4.800×10^{10}
June	2.346×10^{10}	1.066×10^{10}
July	4.129×10^{10}	1.410×10^{10}
August	5.286×10^{10}	8.514×10^{9}
September	1.081×10^{11}	1.277×10^{10}
October	1.177×10^{11}	1.258×10^{10}
November	2.196×10^{10}	4.629×10^{9}
December	8.873×10^{9}	1.337×10^{9}
Total	5.413×10^{11}	2.496×10^{11}
1977		
January	2.652×10^{9}	1.237×10^{9}
February	8.759×10^{9}	4.110×10^{9}
March	1.162×10^{10}	5.453×10^{9}

[a] Adapted from Blanchet, Avery, and Leverone (1977).

Table 6-41. Estimated entrainment of fish eggs, grouped by family, within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system at Big Bend Station, January-December 1976[a]

Taxon	Number of eggs entrained	Percentage of total eggs entrained
Sciaenidae (drum)	1.2×10^{11}	67
Engraulidae (anchovy)	5.795×10^{10}	31
Clupeidae (herring)	7.464×10^{8}	0.4
Carangidae (jacks/pompano)	5.452×10^{8}	0.2
Soleidae (soles)	1.171×10^{8}	0.06
Triglidae (searobins)	3.782×10^{7}	0.02
Cyprinodontidae (killifish)	1.780×10^{7}	0.01
Ephippidae (spadefish)	1.757×10^{7}	0.009
Pomadasyidae (grunts)	1.201×10^{7}	0.006
Unidentified	5.782×10^{6}	0.003
Belonidae (needlefish)	1.468×10^{6}	0.0008
Gobiidae (gobies)	3.683×10^{5}	0.0002
Atherinidae (silversides)	2.286×10^{5}	0.0001

[a] Adapted from U.S. Environmental Protection Agency (1980).

Table 6-42. Estimated entrainment of fish larvae, grouped by family, within the condenser cooling system of Units 1, 2, and 3 and the dilution pumping system at Big Bend Station, January-December 1976[a]

Taxon	Number of larvae entrained	Percentage of total larvae entrained
Engaulidae (anchovies)	3.352×10^{10}	87
Gobiidae (gobies)	1.613×10^{9}	4
Sciaenidae (drum)	1.3×10^{9}	3
Pomadasyidae (grunts)	9.052×10^{8}	2
Sparidae (porgies)	6.028×10^{8}	2
Carangidae (jacks/pompano)	3.541×10^{8}	1
Blennidae (blennies)	1.756×10^{8}	0.5
Clupeidae (herring)	7.408×10^{7}	0.2
Soleidae (soles)	9.546×10^{7}	0.2
Atherinidae (silversides)	7.569×10^{7}	0.2
Unidentified	8.352×10^{7}	0.2
Triglidae (searobins)	4.006×10^{7}	0.1
Gobiesocidae (clingfish)	2.290×10^{7}	0.06
Syngnathidae (pipefish/seahorse)	2.746×10^{6}	0.007
Tetraodontidae (puffers)	1.517×10^{6}	0.004
Cynoglossidae (tonguefish)	9.062×10^{5}	0.002
Ephippidae (spadefish)	3.674×10^{5}	0.001
Cyprinodontidae (killifish)	2.286×10^{5}	0.0006

[a] Adapted from U.S. Environmental Protection Agency (1980).

Table 6-43. Estimated number of eggs and larvae of *Anchoa mitchilli* entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Eggs		Larvae	
	Condenser entrainment	Dilution pump entrainment	Condenser entrainment	Dilution pump entrainment
1976				
January	0	0	0	0
February	2.582×10^{7}	0	0	0
March	2.398×10^{8}	3.757×10^{9}	1.949×10^{6}	1.659×10^{9}
April	9.579×10^{9}	7.245×10^{9}	4.614×10^{9}	3.044×10^{9}
May	1.350×10^{10}	1.141×10^{10}	3.950×10^{9}	1.828×10^{9}
June	3.429×10^{9}	3.168×10^{9}	9.439×10^{8}	4.089×10^{8}
July	1.673×10^{9}	3.414×10^{9}	4.197×10^{9}	2.901×10^{9}
August	1.613×10^{8}	1.960×10^{8}	5.934×10^{9}	5.426×10^{8}
September	9.298×10^{7}	3.338×10^{7}	2.902×10^{9}	2.103×10^{8}
October	2.672×10^{7}	0	3.689×10^{8}	1.487×10^{7}
November	0	0	8.343×10^{5}	1.447×10^{6}
December	0	0	0	0
Total	2.873×10^{10}	2.922×10^{10}	2.291×10^{10}	1.061×10^{10}
1977				
January	0	0	0	0
February	0	1.306×10^{5}	0	0
March	1.362×10^{10}	6.885×10^{9}	1.036×10^{9}	2.578×10^{8}

[a] Adapted from Phillips et al. (1977).

Table 6-44. Estimated number of eggs and larvae of Sciaenidae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

	Eggs		Larvae	
Month	Condenser entrainment	Dilution pump entrainment	Condenser entrainment	Dilution pump entrainment
1976				
January	0	0	0	0
February	4.471×10^{6}	0	0	0
March	3.062×10^{7}	1.438×10^{10}	2.784×10^{5}	8.110×10^{7}
April	3.024×10^{6}	2.661×10^{10}	1.837×10^{8}	1.530×10^{8}
May	1.863×10^{10}	2.028×10^{10}	1.339×10^{8}	1.758×10^{8}
June	3.490×10^{9}	4.582×10^{9}	3.508×10^{7}	3.733×10^{7}
July	2.681×10^{9}	3.468×10^{9}	1.083×10^{8}	1.538×10^{8}
August	4.316×10^{8}	1.601×10^{8}	1.138×10^{8}	3.164×10^{7}
September	1.854×10^{8}	3.272×10^{7}	4.094×10^{7}	1.262×10^{7}
October	1.779×10^{7}	0	5.852×10^{6}	1.792×10^{6}
November	9.646×10^{5}	8.172×10^{4}	0	0
December	2.994×10^{5}	1.532×10^{4}	0	0
Total	5.571×10^{10}	6.951×10^{10}	6.219×10^{8}	6.471×10^{8}
1977				
January	0	3.581×10^{4}	2.437×10^{6}	3.581×10^{4}
February	1.648×10^{6}	3.979×10^{6}	1.171×10^{6}	1.909×10^{5}
March	5.587×10^{7}	3.856×10^{7}	7.511×10^{6}	4.546×10^{6}

[a] Adapted from Phillips et al. (1977).

Table 6-45. Estimated number of eggs and larvae of *Harengula jaguana* entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Eggs		Larvae	
	Condenser entrainment	Dilution pump entrainment	Condenser entrainment	Dilution pump entrainment
1976				
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	1.719×10^7	3.983×10^6	3.948×10^6	1.945×10^5
May	5.113×10^8	8.232×10^7	3.352×10^6	4.019×10^6
June	2.980×10^7	8.958×10^6	1.342×10^6	7.575×10^6
July	4.186×10^7	4.923×10^7	1.629×10^7	3.524×10^7
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0
Total	6.002×10^8	1.445×10^8	2.493×10^7	4.703×10^7
1977				
January	0	0	0	0
February	0	0	0	
March	0	0	0	0

[a]Adapted from Phillips et al. (1977).

Table 6-46. Estimated number of *Pinnixa sayana* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Condenser entrainment	Dilution pump entrainment
1976		
January	0	0
February	5.516×10^{7}	0
March	4.660×10^{9}	1.453×10^{10}
April	3.728×10^{10}	2.661×10^{10}
May	1.701×10^{10}	1.504×10^{10}
June	1.048×10^{10}	3.330×10^{9}
July	2.623×10^{10}	7.171×10^{9}
August	1.689×10^{10}	2.138×10^{9}
September	3.945×10^{10}	2.677×10^{9}
October	8.028×10^{10}	7.078×10^{9}
November	2.475×10^{9}	1.629×10^{9}
December	7.566×10^{7}	7.830×10^{6}
Total	2.349×10^{11}	8.021×10^{10}
1977		
January	0	0
February	4.533×10^{9}	1.850×10^{9}
March	6.387×10^{9}	2.606×10^{9}

[a] Adapted from Blanchet, Avery, and Leverone (1977).

Table 6-47. Estimated number of *Polyonyx gibbesi* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Condenser entrainment	Dilution pump entrainment
1976		
January	1.841×10^{6}	0
February	1.024×10^{7}	0
March	1.770×10^{9}	2.551×10^{10}
April	1.076×10^{10}	4.646×10^{10}
May	4.765×10^{10}	2.105×10^{10}
June	5.653×10^{9}	3.757×10^{9}
July	3.724×10^{9}	1.117×10^{9}
August	8.849×10^{8}	2.138×10^{8}
September	2.208×10^{10}	4.134×10^{8}
October	1.026×10^{10}	6.877×10^{8}
November	6.640×10^{9}	1.686×10^{8}
December	1.071×10^{7}	5.860×10^{6}
Total	1.094×10^{11}	9.938×10^{10}
1977		
January	0	1.446×10^{6}
February	0	4.900×10^{5}
March	0	2.961×10^{5}

[a] Adapted from Blanchet, Avery, and Leverone (1977).

Table 6-48. Estimated number of *Upogebia affinis* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Condenser entrainment	Dilution pump entrainment
1976		
January	0	0
February	0	0
March	7.748×10^{8}	3.951×10^{9}
April	1.082×10^{10}	7.365×10^{9}
May	1.220×10^{10}	6.750×10^{9}
June	3.296×10^{9}	1.501×10^{9}
July	2.167×10^{9}	1.498×10^{9}
August	6.889×10^{9}	7.896×10^{8}
September	7.352×10^{9}	1.160×10^{9}
October	1.095×10^{9}	3.494×10^{8}
November	3.455×10^{7}	3.669×10^{7}
December	8.939×10^{6}	5.140×10^{6}
Total	4.464×10^{10}	2.341×10^{10}
1977		
January	0	2.892×10^{5}
February	2.963×10^{7}	3.523×10^{6}
March	4.174×10^{7}	4.885×10^{6}

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[a] Adapted from Blanchet, Avery, and Leverone (1977).

Table 6-49. Estimated number of *Neopanope texana* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Condenser entrainment	Dilution pump entrainment
1976		
January	0	0
February	0	0
March	1.668×10^{8}	3.736×10^{8}
April	9.108×10^{8}	6.851×10^{8}
May	6.235×10^{8}	4.061×10^{8}
June	1.381×10^{9}	2.958×10^{8}
July	9.172×10^{8}	4.686×10^{8}
August	1.221×10^{10}	1.138×10^{9}
September	1.294×10^{10}	2.686×10^{9}
October	1.147×10^{10}	1.409×10^{9}
November	1.037×10^{9}	5.215×10^{8}
December	2.534×10^{8}	1.035×10^{8}
Total	4.191×10^{10}	8.087×10^{9}
1977		
January	2.728×10^{6}	1.879×10^{6}
February	8.786×10^{7}	3.335×10^{7}
March	1.231×10^{8}	4.648×10^{7}

[a] Adapted from Blanchet, Avery, and Leverone (1977).

Table 6-50. Estimated number of *Menippe mercenaria* larvae entrained within the condenser cooling system of Units 1, 2, and 3 and within the dilution pumping system of Big Bend Station, January 1976-March 1977[a]

Month	Condenser entrainment	Dilution pump entrainment
1976		
January	0	0
February	0	0
March	6.453×10^7	1.779×10^8
April	5.642×10^8	3.237×10^8
May	2.782×10^8	1.416×10^8
June	3.485×10^9	1.748×10^8
July	5.306×10^8	3.579×10^8
August	1.025×10^9	2.105×10^8
September	1.742×10^9	4.965×10^8
October	4.529×10^8	9.596×10^7
November	1.585×10^7	9.525×10^6
December	9.729×10^5	1.059×10^6
Total	5.023×10^9	1.989×10^9
1977		
January	0	0
February	0	0
March	0	0

[a] Adapted from Blanchet, Avery, and Leverone (1977).

Table 6-51. Monthly RIS entrainment estimates for four Big Bend Units at 100 percent flow capacity

Species and life stage	1979										1980	
	March	April	May	June	July	August	September	October	November	December	January	February
Penaeus duorarum												
Postlarvae	0	0	0	1.27×10^{5}	3.39×10^{6}	2.25×10^{6}	8.79×10^{6}	4.07×10^{6}	0	0	0	0
Callinectes sapidus	0	0	0	0	0	0	0	0	0	0	0	0
Menippe mercenaria												
Stage 1 zoea	1.18×10^{7}	3.32×10^{8}	7.89×10^{8}	6.04×10^{8}	4.58×10^{8}	5.14×10^{7}	8.79×10^{6}	6.73×10^{5}	9.60×10^{5}	5.37×10^{5}	6.08×10^{3}	1.83×10^{4}
Stage 2 zoea	2.09×10^{5}	2.19×10^{6}	1.68×10^{7}	4.84×10^{7}	5.38×10^{7}	3.24×10^{6}	2.06×10^{5}	0	0	0	0	0
Stage 3 zoea	0	0	2.93×10^{6}	1.21×10^{7}	1.70×10^{7}	1.66×10^{5}	1.20×10^{5}	0	0	0	0	0
Stage 4 zoea	0	5.40×10^{4}	4.17×10^{5}	1.60×10^{6}	2.17×10^{6}	1.16×10^{5}	8.34×10^{4}	0	0	0	0	0
Stage 5 zoea	0	0	5.94×10^{4}	7.76×10^{5}	2.81×10^{6}	0	0	0	0	0	0	0
Anchoa mitchilli												
Eggs	4.29×10^{9}	8.90×10^{9}	1.82×10^{10}	2.43×10^{10}	2.88×10^{10}	1.08×10^{10}	7.88×10^{8}	8.35×10^{7}	0	0	2.41×10^{5}	2.01×10^{8}
Prolarvae	2.30×10^{8}	1.72×10^{8}	2.21×10^{8}	2.24×10^{8}	1.47×10^{8}	4.74×10^{7}	6.19×10^{6}	1.15×10^{6}	0	0	0	7.68×10^{6}
Postlarvae	3.62×10^{8}	1.33×10^{9}	1.76×10^{9}	3.11×10^{9}	3.06×10^{9}	3.10×10^{8}	1.01×10^{8}	2.43×10^{7}	4.11×10^{5}	5.96×10^{4}	0	1.23×10^{6}
Harengula jaguana												
Eggs	0	0	1.88×10^{7}	3.59×10^{7}	4.94×10^{6}	0	0	0	0	0	0	0
Prolarvae	0	0	3.77×10^{8}	6.38×10^{8}	4.04×10^{8}	0	0	0	0	0	0	0
Postlarvae	0	1.94×10^{5}	4.21×10^{7}	1.39×10^{8}	1.58×10^{8}	0	0	0	0	0	0	0
Menidia beryllina												
Eggs	0	0	0	0	0	0	0	0	0	0	0	0
Prolarvae	0	0	0	0	0	0	0	0	0	0	0	0
Postlarvae	2.80×10^{5}	3.62×10^{5}	5.46×10^{5}	3.39×10^{5}	0	0	0	0	0	3.47×10^{4}	3.97×10^{4}	0
Bairdiella chrysoura												
Eggs	3.47×10^{7}	1.55×10^{9}	6.35×10^{9}	2.12×10^{7}	7.50×10^{8}	1.37×10^{8}	8.38×10^{5}	0	0	0	5.45×10^{5}	1.36×10^{6}
Prolarvae	3.56×10^{6}	2.46×10^{6}	7.10×10^{6}	2.95×10^{6}	4.43×10^{4}	0	0	0	0	0	0	1.50×10^{5}
Postlarvae	1.08×10^{6}	4.55×10^{6}	7.06×10^{6}	2.23×10^{6}	1.74×10^{5}	0	0	0	0	0	0	2.16×10^{4}
Cynoscion nebulosus												
Eggs	0	0	0	0	0	0	0	0	0	0	0	0
Prolarvae	0	0	0	1.27×10^{5}	1.70×10^{5}	0	0	0	0	0	0	0
Postlarvae	2.39×10^{5}	3.23×10^{5}	1.88×10^{6}	1.75×10^{6}	1.31×10^{6}	1.04×10^{5}	3.02×10^{5}	7.54×10^{4}	0	0	0	0
Unidentified Cynoscion												
Eggs	3.10×10^{5}	6.30×10^{6}	2.19×10^{7}	3.43×10^{5}	0	0	0	0	0	0	8.01×10^{4}	1.88×10^{4}
Prolarvae	1.34×10^{5}	6.35×10^{4}	0	0	0	0	0	0	0	0	1.02×10^{5}	1.70×10^{5}
Postlarvae	0	0	0	0	0	0	0	0	0	0	0	0
Pogonias cromis												
Eggs	3.40×10^{4}	7.29×10^{6}	3.36×10^{7}	6.06×10^{5}	0	0	0	0	0	6.5×10^{4}	6.94×10^{5}	0
Prolarvae	5.05×10^{5}	2.43×10^{6}	2.20×10^{6}	1.17×10^{6}	2.73×10^{5}	1.43×10^{5}	0	0	0	0	0	9.65×10^{3}
Postlarvae	6.24×10^{5}	1.93×10^{6}	1.50×10^{5}	0	0	0	0	0	0	0	0	0
Unidentified sciaenid												
Eggs	1.89×10^{8}	9.77×10^{9}	3.30×10^{10}	2.21×10^{10}	1.50×10^{10}	2.50×10^{9}	2.10×10^{7}	1.76×10^{6}	3.83×10^{5}	0	1.20×10^{6}	1.48×10^{6}
Prolarvae	4.04×10^{5}	2.81×10^{5}	8.69×10^{5}	8.31×10^{5}	1.45×10^{5}	5.49×10^{5}	0	0	0	0	4.86×10^{4}	8.11×10^{4}
Postlarvae	0	0	0	0	0	0	0	0	0	0	0	0

Table 6-52. Viability of fish eggs impinged on the prototype fine-mesh screen at Big Bend Station, March-August 1980[a],[b]

Taxon	Initial survival			Hatchability			48-hour survival of hatched egg			96-hour survival of hatched egg		
	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error
Clupeiformes	327 (16)	0.432 (0.855)	0.014 (0.028)	322 (20)	0.810 (0.893)	0.007 (0.032)	322 (20)	0.844 (0.903)	0.006 (0.021)	322 (20)	0.624 (0.686)	0.016 (0.059)
Harengula jaguana	69 (8)	0.458 (0.996)	0.044 (0.002)	71 (8)	0.929 (0.985)	0.013 (0.009)	71 (8)	0.828 (0.922)	0.030 (0.033)	71 (8)	0.459 (0.276)	0.044 (0.133)
Anchoa mitchilli	320 (16)	0.433 (0.850)	0.015 (0.027)	314 (20)	0.800 (0.886)	0.007 (0.032)	314 (20)	0.839 (0.900)	0.007 (0.022)	314 (20)	0.637 (0.720)	0.015 (0.052)
Sciaenidae	268 (13)	0.753 (0.984)	0.017 (0.130)	283 (18)	0.948 (0.990)	0.006 (0.003)	283 (18)	0.843 (0.913)	0.012 (0.039)	283 (18)	0.697 (0.827)	0.018 (0.049)
Bairdiella chrysoura	175 (6)	1.000 (1.000)	0.000 (0.000)	195 (10)	1.000 (1.000)	0.000 (0.000)	195 (10)	0.991 (0.994)	0.003 (0.004)	195 (20)	0.979 (0.978)	0.006 (0.016)
Cynoscion spp.	135 (12)	1.000 (1.000)	0.000 (0.000)	184 (17)	1.000 (1.000)	0.000 (0.000)	184 (17)	0.994 (0.993)	0.003 (0.007)	184 (17)	0.894 (0.969)	0.019 (0.021)
Menticirrhus spp.	183 (11)	1.000 (1.000)	0.000 (0.000)	221 (14)	1.000 (1.000)	0.000 (0.000)	221 (14)	0.997 (1.000)	0.002 (0.000)	221 (14)	0.884 (0.915)	0.020 (0.071)
Pogonias cromis	14 (--)	1.000 (--)	0.000 (--)	17 (--)	1.000 (--)	0.000 (--)	17 (--)	0.882 (--)	0.081 (--)	17 (--)	0.853 (--)	0.083 (--)

[a] Adapted from Tampa Electric Company (1980d).

[b] Numbers in parentheses are data for control organisms. A dash denotes no observation.

[c] Proportion surviving.

Table 6-53. Viability of fish larvae impinged on the prototype fine-mesh screen at Big Bend Station, March-August 1980[a],[b]

Taxon	Initial survival			48-hour survival			96-hour survival		
	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error
Clupeiformes	278 (11)	0.015 (0.104)	0.006 (0.035)	11 (1)	0.364 (0.000)	0.152 (0.000)	11 (1)	0.364 (0.000)	0.152 (0.000)
Harengula jaguana	15 (--)	0.000 (--)	0.000 (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
Anchoa mitchilli	274 (10)	0.015 (0.114)	0.007 (0.037)	9 (1)	0.222 (0.000)	0.147 (0.000)	9 (1)	0.222 (0.000)	0.147 (0.000)
Sciaenidae	108 (6)	0.186 (0.444)	0.035 (0.205)	26 (1)	0.109 (0.000)	0.050 (0.000)	26 (1)	0.101 (0.000)	0.048 (0.000)
Bairdiella chrysoura	39 (2)	0.192 (0.500)	0.060 (0.500)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
Cynoscion spp.	51 (1)	0.157 (0.000)	0.051 (0.000)	3 (--)	1.000 (--)	0.000 (0.000)	3 (--)	1.000 (--)	0.000 (--)
Menticirrhus spp.	15 (4)	0.000 (0.250)	0.000 (0.250)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)
Pogonias cromis	7 (1)	0.429 (1.000)	0.202 (0.000)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)	-- (--)

[a] Adapted from Tampa Electric Company (1980d).
[b] Numbers in parentheses are data for control organisms. A dash denotes no observation.
[c] Proportion surviving.

Table 6-54. Viability of the zoeal stages of various decapod crustacean macroinvertebrates impinged on the prototype fine-mesh screen at Big Bend Station, March-August 1980[a],[b]

Taxon	Initial survival			48-hour survival			96-hour survival		
	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error
Caridea	195 (10)	0.943 (0.767)	0.013 (0.132)	185 (8)	0.850 (0.868)	0.015 (0.083)	185 (8)	0.500 (0.438)	0.024 (0.126)
Upogebia affinis	221 (13)	0.913 (0.756)	0.016 (0.107)	194 (11)	0.841 (0.762)	0.014 (0.117)	194 (11)	0.428 (0.454)	0.027 (0.124)
Paguridae	111 (2)	0.949 (1.000)	0.020 (0.000)	85 (3)	0.966 (1.000)	0.017 (0.000)	85 (3)	0.792 (0.333)	0.039 (0.333)
Brachyura	335 (14)	0.955 (0.650)	0.005 (0.107)	238 (9)	0.839 (0.556)	0.019 (0.176)	238 (9)	0.459 (0.278)	0.026 (0.147)
Xanthidae	333 (--)	0.991 (--)	0.003 (--)	325 (19)	0.959 (0.956)	0.004 (0.013)	325 (19)	0.749 (0.734)	0.015 (0.065)
Menippe mercenaria	235 (11)	0.979 (0.973)	0.005 (0.018)	189 (12)	0.915 (0.949)	0.014 (0.025)	189 (12)	0.583 (0.610)	0.028 (0.126)
Pinnotheridae	292 (11)	1.000 (1.000)	0.000 (0.000)	293 (14)	0.922 (0.934)	0.009 (0.034)	293 (14)	0.730 (0.721)	0.018 (0.080)
Grapsizoea	228 (13)	1.000 (1.000)	0.000 (0.000)	229 (16)	0.951 (0.979)	0.008 (0.010)	229 (16)	0.802 (0.929)	0.017 (0.024)

[a] Adapted from Tampa Electric Company (1980d).
[b] Numbers in parentheses are data for control organisms. A dash denotes no observation.
[c] Proportion surviving.

Table 6-55. Viability of the megalops stage of various decapod crustacean macroinvertebrates impinged on the prototype fine-mesh screen at Big Bend Station, March-August 1980[a],[b]

Taxon	Initial survival			48-hour survival			96-hour survival		
	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error	Number of observations	Mean[c]	Standard error
Caridea	1 (--)	1.000 (--)	0.000 (--)	1 (--)	1.000 (--)	0.000 (--)	1 (--)	1.000 (--)	0.000 (--)
Upogebia affinis	67 (1)	1.000 (1.000)	0.000 (0.000)	97 (1)	0.977 (1.000)	0.010 (0.000)	97 (1)	0.743 (1.000)	0.039 (0.000)
Paguridae	5 (--)	1.000 (--)	0.000 (--)	10 (--)	0.900 (--)	0.0001 (--)	10 (--)	0.800 (--)	0.0002 (--)
Brachyura	124 (5)	0.651 (0.267)	0.041 (0.194)	65 (--)	0.718 (--)	0.045 (--)	65 (--)	0.150 (--)	0.0003 (--)
Xanthidae	189 (4)	1.000 (1.000)	0.000 (0.000)	214 (8)	0.983 (1.000)	0.006 (0.000)	214 (8)	0.942 (0.969)	0.010 (0.031)
Menippe mercenaria	5 (--)	1.000 (--)	0.000 (--)	6 (--)	1.000 (--)	0.000 (--)	6 (--)	1.000 (--)	0.000 (--)
Pinnotheridae	19 (--)	1.000 (--)	0.000 (--)	28 (--)	1.000 (--)	0.000 (--)	28 (--)	0.929 (--)	0.050 (--)
Grapsizoea	110 (9)	1.000 (1.000)	0.000 (0.000)	179 (11)	0.981 (1.000)	0.004 (0.000)	179 (11)	0.931 (0.912)	0.008 (0.051)

[a] Adapted from Tampa Electric Company (1980d).
[b] Numbers in parentheses are data for control organisms. A dash indicates no observation.
[c] Proportion surviving.

Table 6-56. Analysis of variance in the survival of fish impinged on fine-mesh screens at Big Bend Station

Dependent variable	Total degrees of freedom	F-statistic				
		Temperature	Screen speed	Approach velocity	Interaction	R^2
Sciaenids						
Egg initial survival	267	16.70[a]	1.13	8.34[a]	3.16	0.132
Egg hatchability	282	21.00[a]	1.98	8.70[a]	0.50	0.119
Hatched-egg survival						
48 hr	282	35.54[a]	0.16	19.41[a]	0.06	0.165
96 hr	282	45.74[a]	1.45	14.54[a]	0.48	0.203
Larvae survival						
Initial	107	4.20[b]	0.17	0.05	0.06	0.044
48 hr	25	0.03	0.05	1.65	0.09	0.104
96 hr	25	0.00	0.13	1.74	0.12	0.119
Cynoscion spp.						
Egg initial survival[c]	134					
Egg hatchability[c]	183					
Hatched-egg survival						
48 hr	183	4.81[b]	1.32	0.00	0.94	0.045
96 hr	183	114.98[b]	1.76	0.48	0.60	0.403
Larvae survival						
Initial	50	0.60	0.48	1.05	0.03	0.064
48 hr	2[c]					
96 hr	2[c]					
Anchoa mitchilli						
Egg initial survival	319	9.39[a]	0.33	0.25	1.64	0.046
Egg hatchability	313	66.05[a]	1.84	2.18	1.33	0.200
Hatched-egg survival						
48 hr	313	0.93	0.05	1.76	0.45	0.013
96 hr	313	364.00[a]	3.16	2.43	0.62	0.552
Larvae survival						
Initial	273	3.84	1.26	0.09	0.67	0.028
48 hr	8	3.03	(d)	0.19	(d)	0.360
96 hr	8	3.03	(d)	0.19	(d)	0.360

[a] $P \le .01$.

[b] $P \le .05$.

[c] No variability in this dependent variable.

[d] Insufficient observations to estimate this variable.

Table 6-57. Analysis of variance in the survival of invertebrates impinged on fine-mesh screens at Big Bend Station

Dependent variable (survival)	Total degrees of freedom	F-statistic				R^2
		Temperature	Screen speed	Approach velocity	Interaction[a]	
Brachyura						
Zoea, initial	334	4.47[b]	0.68	0.15	1.37	0.025
Zoea, 48 hr	237	0.86	0.08	0.21	0.48	0.010
Zoea, 96 hr	237	36.71[c]	0.08	0.01	0.09	0.139
Megalops, initial	123	7.76[c]	1.17	0	1.10	0.093
Megalops, 48 hr	64	1.09	0.15	0.14	2.62	0.120
Megalops, 96 hr	64	14.81[c]	0.41	0.30	1.14	0.248
Xanthidae						
Zoea, initial	0					
Zoea, 48 hr	324	51.00[c]	1.34	10.09[b]	0.96	0.192
Zoea, 96 hr	324	381.38[c]	1.47	0.10	0.40	0.562
Megalops, initial[d]	188					
Megalops, 48 hr	213	3.16	0.38	0.55	1.34	0.032
Megalops, 96 hr	213	15.36[c]	0.76	0.26	0.97	0.086
Mennippe mercenaria						
Zoea, initial	234	17.15[c]	0.29	2.06	0.35	0.088
Zoea, 48 hr	188	5.14[b]	2.69	0.20	0.16	0.060
Zoea, 96 hr	188	124.90[b]	6.19[c]	0.95	0.49	0.456

[a] Interaction between screen speed and approach velocity.

[b] $P \leq .05$.

[c] $P \leq .01$.

[d] No variability in this dependent variable.

Table 6-58. Taxonomic groups recovered and identified in spray-wash efficiency sampling conducted at Big Bend Station during April-July 1980

Taxonomic group	Taxon
Anchoa mitchilli	*Anchoa mitchilli*[a]
Invertebrate "zoea"	Unidentified invertebrate zoea
	Caridea
	Penaeidae
	Brachyura (including the xanthid *Menippe mercenaria*[a])
	Thalassinidea
	Anomura
Perciformes	Unidentified Perciformes
	Archosargus probatocephalus
	Unidentified Carangidae
	Unidentified Sciaenidae
	Bairdiella chrysoura[a]
	Menticirrhus spp.
	Pogonias cromis[a]
	Cynoscion arenarius
	Cynoscion nebulosus[a]
	Gobiosoma rubustum
	Orthopristis chrysoptera

[a] Representative important species.

Table 6-59. Results of spray-wash efficiency testing conducted at Big Bend Station during April-July 1980

Taxonomic group	Life stage	Number of observations	Percentage of carryover		Mean of percentage removed
			Range	Mean	
Anchoa mitchilli	Eggs	15	17-100	52.9	47.1
	Larvae	15	13-76	39.5	60.5
"Zoea"	Zoea	15	7.5-43	23.7	76.3
Perciformes	Eggs	15	26-100	52.4	47.6
	Larvae	15	0-100	42.3	57.7

Table 6-60. Taxonomic groups recovered and identified in screening efficiency sampling conducted at Big Bend Station

Taxonomic group	Taxon
Anchoa mitchilli	*Anchoa mitchilli*[a]
Invertebrate "zoea"	Unidentified invertebrate zoea
	Caridea
	Penaeidae
	Brachyura (including the xanthid *Menippe mercenaria*[a])
	Thalassinidea
	Anomura
Perciformes	Unidentified Perciformes
	Archosargus probatocephalus
	Chloroscombrus chrysurus
	Unidentified Sciaenidae
	Bairdiella chrysoura[a]
	Menticirrhus spp.
	Orthopristis chrysoptera

[a] Representative important species.

Table 6-61. Results of screening efficiency testing at Big Bend Station

Taxonomic group	Life stage	Number of observations	Percentage of loss	
			Range	Mean
Anchoa mitchilli	Eggs	4	80.4-88.0	84.9
	Larvae	4	24.6-63.8	42.5
"Zoea"	Zoea	4	14.9-41.2	26.6
Perciformes	Eggs	4	37.8-100	69.8

Table 6-62. Taxonomic groups analyzed in flume and organism survival studies conducted at Big Bend Station from June through August 1980

Taxonomic group	Taxon
Anchoa mitchilli	*Anchoa mitchilli*[a]
Harengula jaguana	*Harengula jaguana*[a]
Perciformes	Unidentified Carangidae
	Chloroscombrus chrysurus
	Oligoplites saurus
	Orthopristis chrysoptera
	Unidentified Sciaenidae
	Bairdiella chrysoura[a]
	Cynoscion arenarius
	Cynoscion nebulosus[a]
	Menticirrhus spp.
	Pogonias cromis[a]
	Microgobius gulosus
Shrimp	Caridea
Crabs	Brachyura (primarily *Pinnixa sayana*)
	Xanthidae (including *Menippe mercenaria*[a])
	Thalassinidea (primarily *Upogebia affinis*)
	Anomura

[a] Representative important species.

Table 6-63. Total 48-hour species survival in flume and organism survival studies at Big Bend Station, June-August 1980

Species	Range of observed values	Mean survival	Numbers of observations of each test type included in the mean[a]
Anchoa mitchilli[b]	22.1-89.4	49.7	C(5), F(10), CR(5), CP(5)
Harengula jaguana[b]	40.0-100.0	76.2	C(3), F(5), CR(3), CP(3)
Perciformes[b]	0-79.4	42.6	C(6), F(9), CR(6), CP(6)
Shrimp[b]	37.5-100.0	69.7	C(8), F(14)
Crabs[c]	44.9-81.4	63.1	C(8), F(15)

[a] Key:

C = Live control organisms collected from screen, placed in flume, and held in intake-canal water

F = Live test organisms collected from screen, run in flume, and held in intake-canal water

CR = Net-collected organisms held in organisms return-canal water

CP = Net-collected organisms held in intake-canal water

[b] Includes eggs, yolk-sac larvae, and postlarvae.

[c] Includes all zoeal life stages.

Table 6-64. Analysis of radionuclide content of coal, bottom ash, and fly ash from a western Kentucky coal (all values in pCi/g)

Material	Ra-226	U-234	U-235	U-238	Th-238	Th-230	Th-232
			June 1976 analysis				
Coal	1.98	0.80	0.04	0.78	0.21	0.71	0.19
Fly ash	7.00	6.30	0.33	8.60	1.90	6.50	1.80
Bottom ash	5.00	5.60	0.22	5.50	1.90	6.00	1.60
			June 1977 analysis				
Coal	0.72	0.92	0.05	0.92	0.34	0.85	0.27
Fly ash	3.80	4.20	0.20	4.40	1.80	4.50	1.57
Bottom ash	3.10	2.70	0.09	2.70	1.70	2.70	1.30

Table 6-65. Average annual radionuclide emissions from a 417-MW powerplant firing different types of coal

Coal	Emission rate (Ci/yr)			
	U[a]	Rn-222	Th[a]	Rn-220
Northern Appalachian	2.08×10^{-4}	7.5×10^{-2}	1.44×10^{-4}	6.86×10^{-2}
Eastern interior	4.71×10^{-4}	1.05×10^{-1}	1.33×10^{-4}	3.86×10^{-2}

[a] Total of all isotopes.

Table 6-66. Radiation doses to human organs from exposure to effluents from a 1,000-MW coal-fired powerplant and from natural background radiation[a]

Organ	Dose rate (mrem/yr)	
	Coal-fired plant	Natural background
Whole body	1.9	80
Lung	1.9	180
Bone	18.2	120

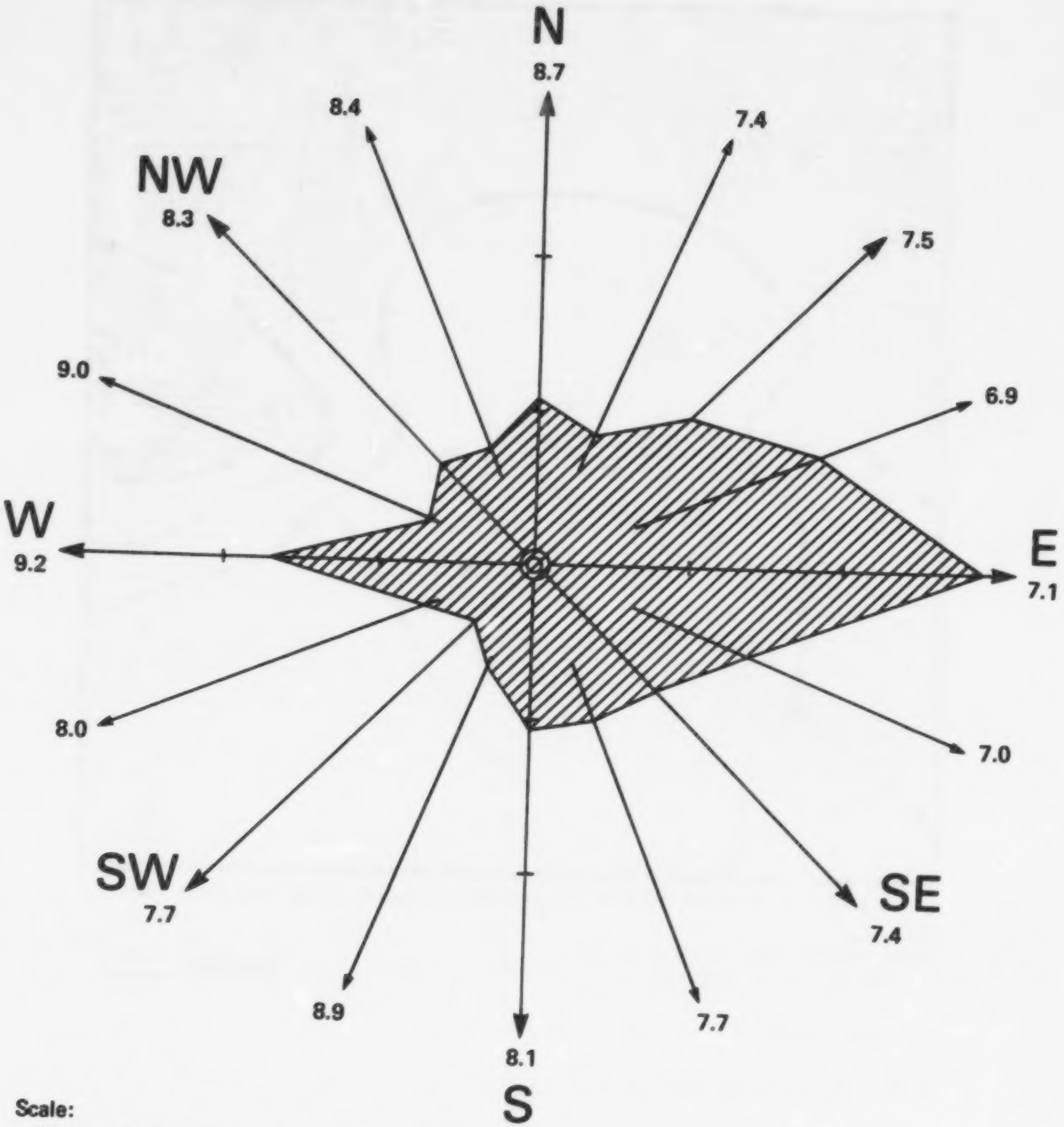
[a] McBride et al. (1977).

Table 6-67. Relationship between severity of salt contamination and the potential for flashover on transmission lines[a]

Flashover potential	Equivalent salt deposit density[b] (mg/cm^2) Engineering Research Council (1975)[b]	Kawai and Sforzini (1974)
Very light	0.02-0.025	0.015-0.03
Light	0.04-0.05	0.03-0.06
Moderate	0.07-0.1	0.06-0.12
Heavy	0.2-0.5	0.12-0.24
Severe	—	0.24-0.48
Extreme	—	0.48

[a] From Stone & Webster Engineering Corporation (1979b).

[b] Report notes that most transmission systems are operating under light contamination.



Scale:
1 in. = 5 percent
Calm = 4.4 percent

Average speeds given in knots

Figure 6-3. Five-year average wind rose for Tampa International Airport, 1971-1975.

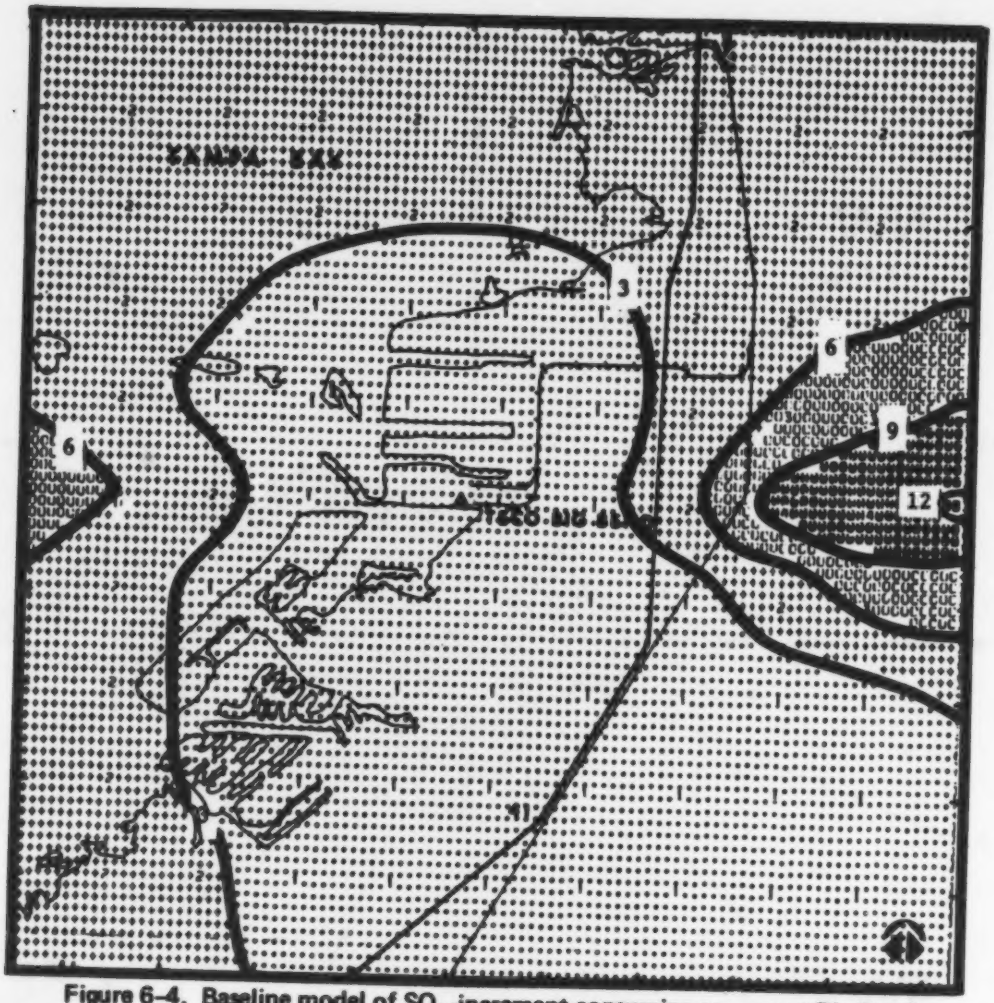


Figure 6-4. Baseline model of SO_2-increment-consuming sources at Big Bend.

```
I
TECO BIG BEND 4 PSP
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
EPA BASELINE OF SO2 INCREMENT CONSUMING SOURCES--BIG BEND SITE


DATA VALUE EXTREMES ARE          1.00        12.10


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM        0.0        3.00        6.00        9.00       12.00
  MAXIMUM        3.00       6.00        9.00       12.00       15.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               20.00      20.00       20.00       20.00       20.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1          2           3           4           5

  SYMBOLS        1          2           3           4           5

  FREQ.         57         50           7           3           1
0.000229 MINUTES FOR HISTOGRAM
```

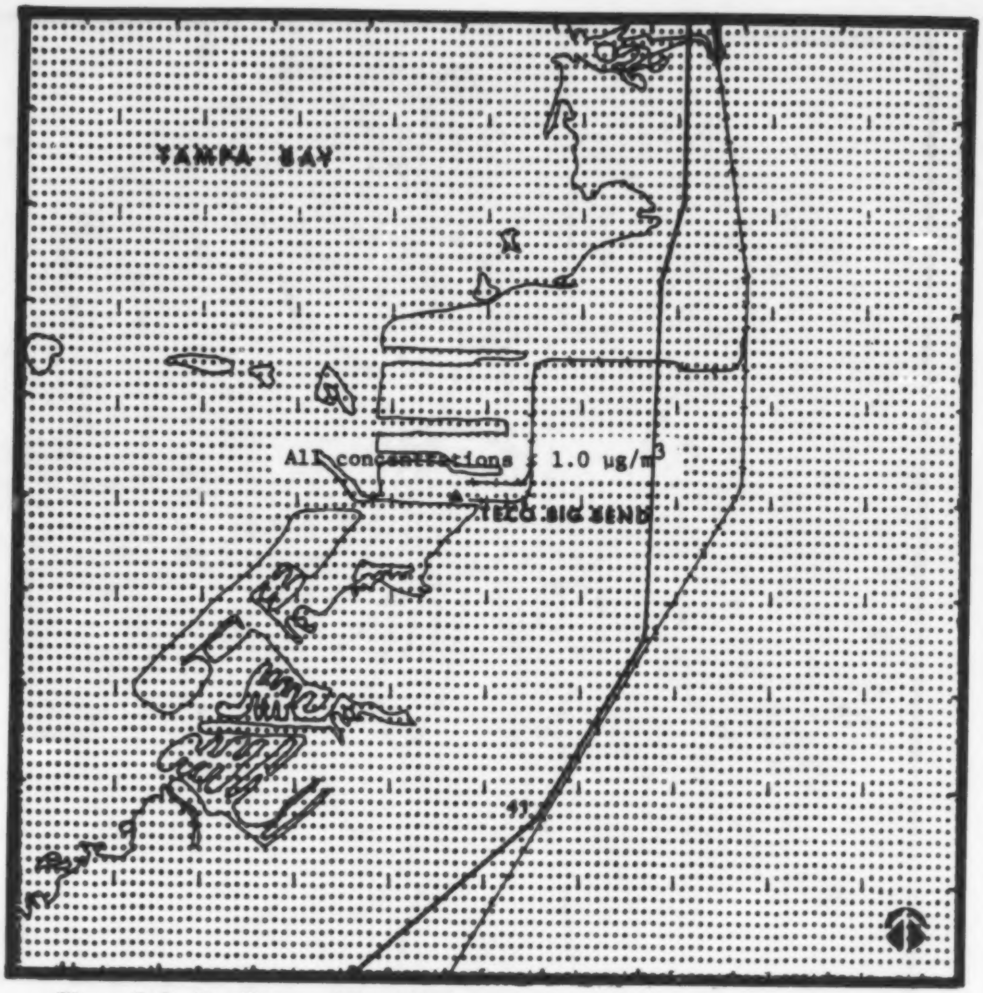


Figure 6-5. Baseline model of TSP-increment-consuming sources at Big Bend.

0 1 2 Kil.

```
TECO BIG BEND 4 TSP
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
EPA BASELINE OF TSP INCREMENT CONSUMING SOURCES--BIG BEND SITE


DATA VALUE EXTREMES ARE          0.10        0.40


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0        0.50
  MAXIMUM      0.50       1.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             50.00      50.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1           2
          ==========================
           ..........  ##########
  SYMBOLS  ....1.....  ####2#####
           ..........  ##########
          ==========================
  FREQ.        121          0
0.00183 MINUTES FOR HISTOGRAM
```

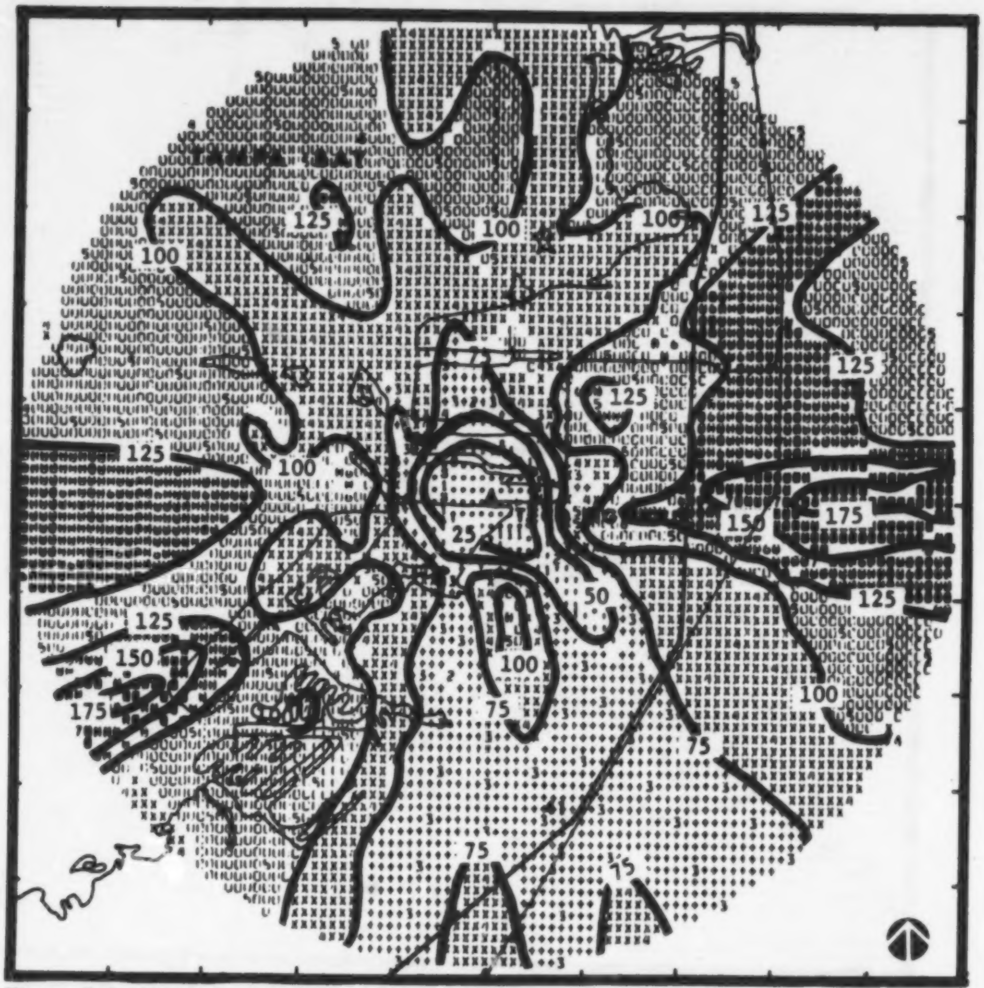
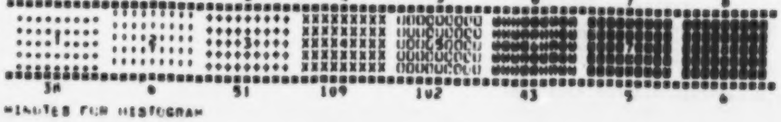

TAMPA BAY
125
100
100
100
125
175
125
125
125
100
175
150
25
50
125
150
125
100
175
75
75
100
75
75
0
1
2 Kil.

Figure 6-6. Estimated 24-hour baseline SO_2 concentrations in the vicinity of Big Bend.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU. M
SO2 24-HOUR COMPOSITE BASELINE CONCENTRATIONS--ALL CASES

DATA VALUE EXTREMES ARE          0.0       187.60

TOTAL SUPERIMPOSED DATA POINTS IS      14.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      0.0      25.00      50.00      75.00     100.00     125.00     150.00     175.00
 MAXIMUM     25.00     50.00      75.00     100.00     125.00     150.00     175.00     200.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

            M12.50     12.50      12.50      12.50      12.50      12.50      12.50      12.50

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL         1          2          3          4          5          6          7          8
```



```
 FREQ.        38          0         51        109        102         43          5          6
0.002896 MINUTES FOR HISTOGRAM
```

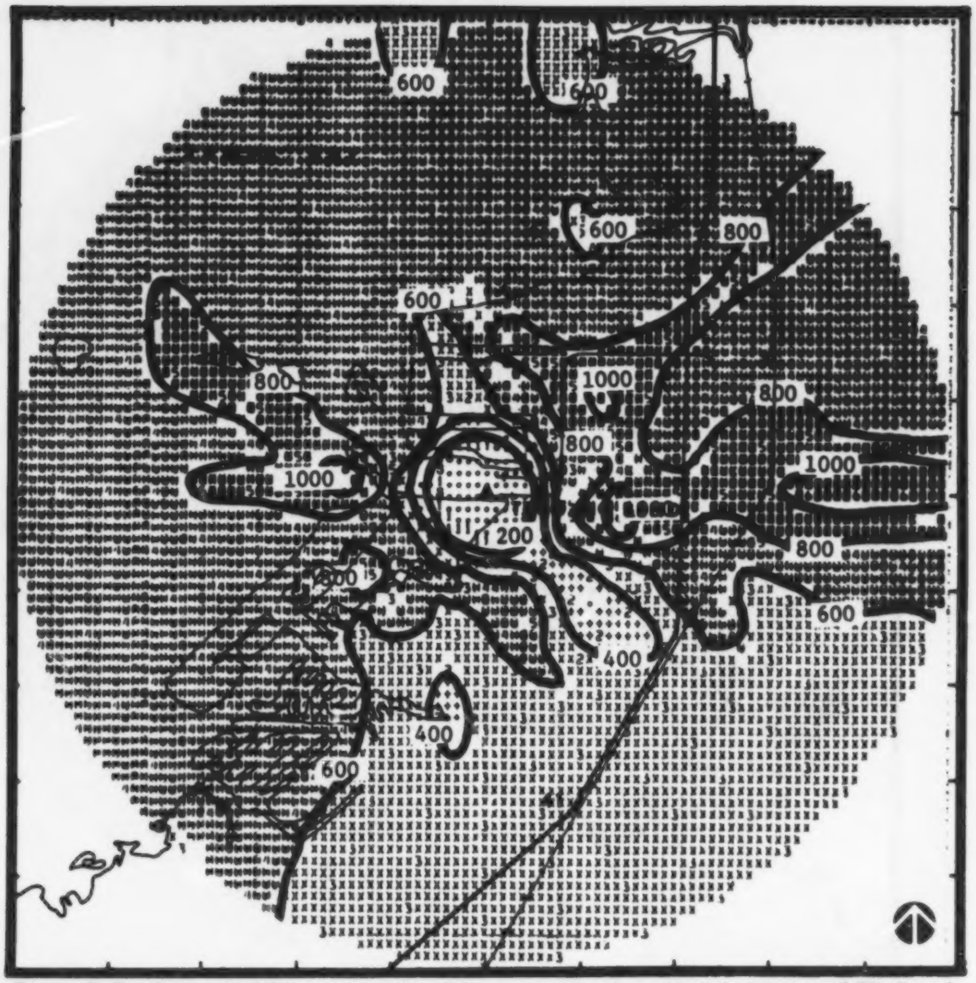
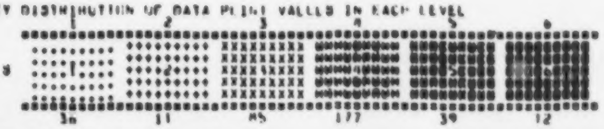


Figure 6-7. Estimated 3-hour baseline SO_2 concentrations in the vicinity of Big Bend.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST  3-HOUR CONCENTRATIONS, UG/CU. M
SO2  3-HOUR COMPOSITE BASELINE CONCENTRATIONS--ALL CASES


DATA VALUE EXTREMES ARE          0.10      1125.00

TOTAL SUPERIMPOSED DATA POINTS IS       14.  THERE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0     200.00     400.00     600.00     800.00    1000.00
  MAXIMUM    200.00     400.00     600.00     800.00    1000.00    1200.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              16.67      16.67      16.67      16.67      16.67      16.67

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL           1          2          3          4          5          6
```



```
  FREQ.           36         11         85        177         39         12
   0.002387 MINUTES FOR HISTOGRAM
```

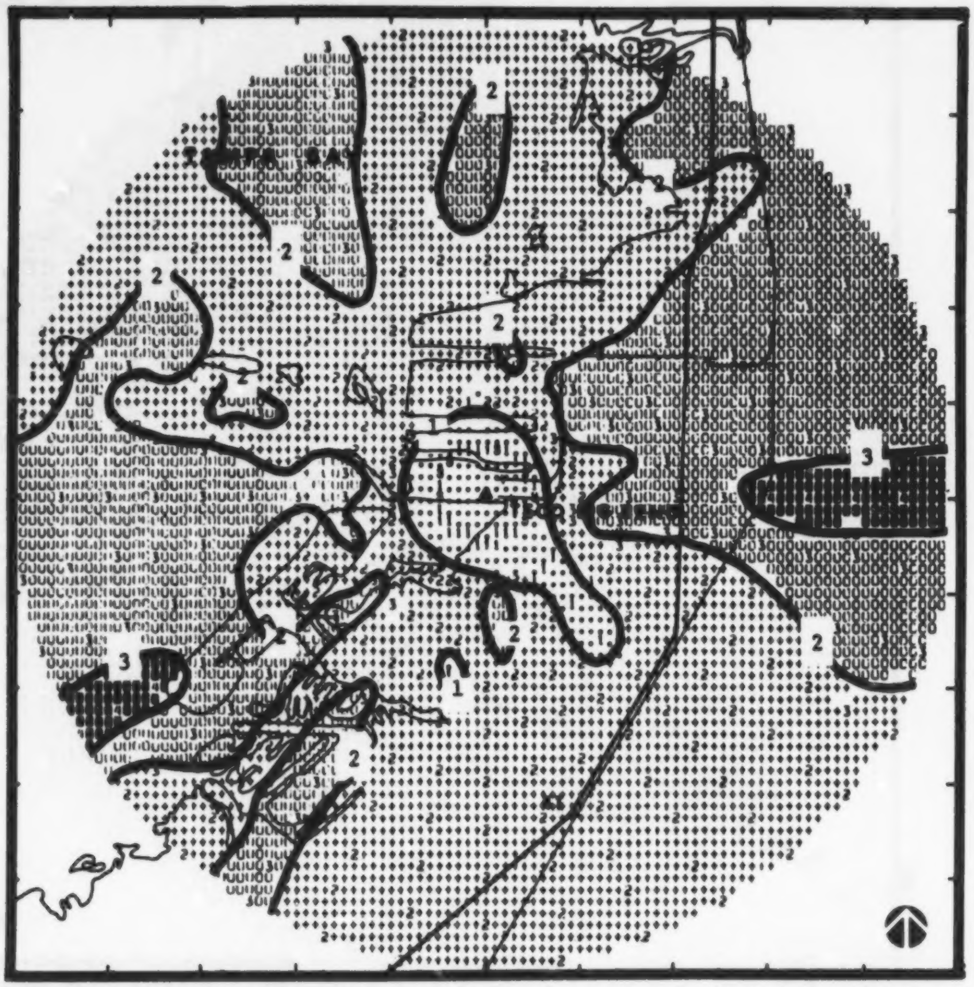


Figure 6-8. Estimated 24-hour baseline TSP concentrations in the vicinity of Big Bend.

```
TECU BIG BEND ONLY
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU. M
TSP 24-HOUR COMPOSITE BASELINE CONCENTRATIONS--ALL CASES


DATA VALUE EXTREMES ARE          0.0          3.60

TOTAL SUPERIMPOSED DATA POINTS IS       14.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0        1.00       2.00       3.00
  MAXIMUM       1.00       2.00       3.00       4.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               25.00      25.00      25.00      25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1          2          3          4
       ******************************************
        .........  +++++++++  UUUUUUUUUU
        .........  +++++++++  UUUUUUUUUU
  SYMBOLS ....1....  ++++2++++  UUUU3UUUUU
        .........  +++++++++  UUUUUUUUUU
        .........  +++++++++  UUUUUUUUUU
       ******************************************
  FREQ.         44        177        131          8
 0.002095 MINUTES FOR HISTOGRAM
```

0 1 2 Kil.

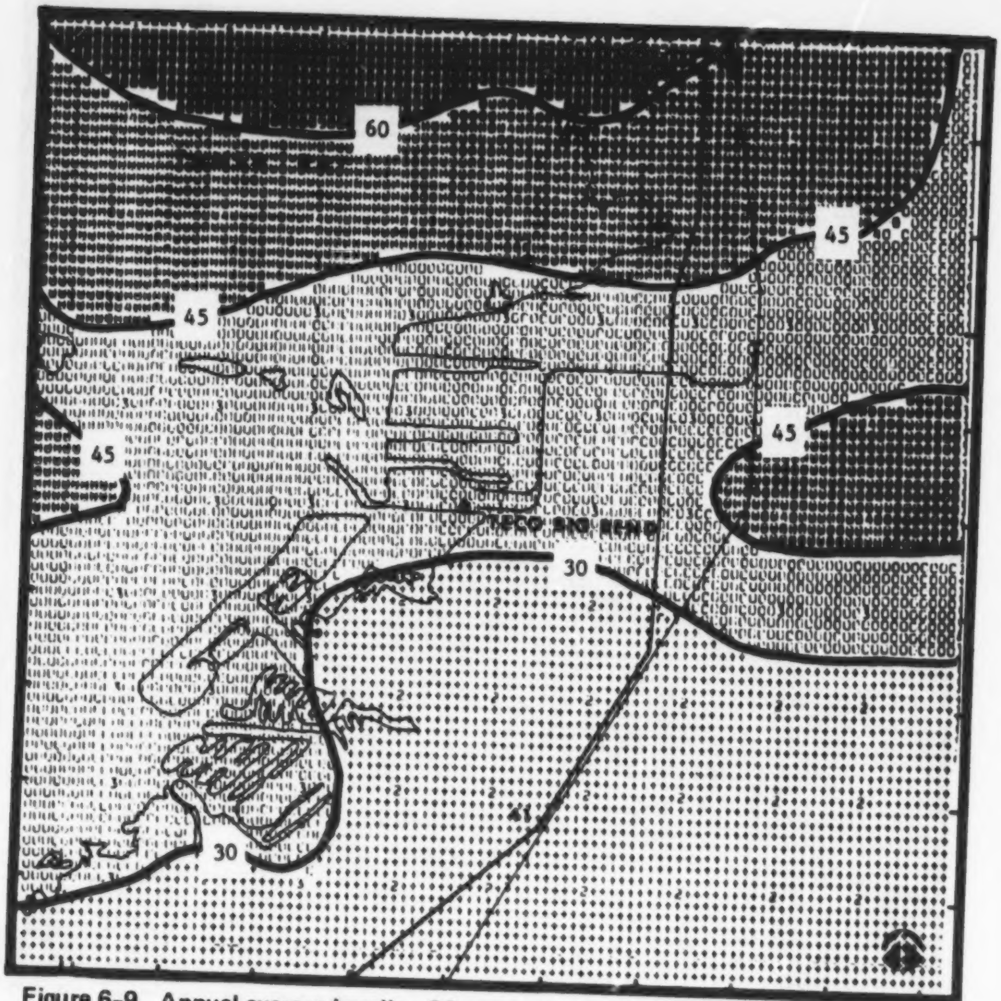


Figure 6-9. Annual average baseline SO_2 concentrations in the vicinity of Big Bend.

```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
PER BASELINE---SO2---BIG BEND SITE


DATA VALUE EXTREMES ARE        21.40       73.90


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM        0.0        15.00       30.00       45.00       60.00
  MAXIMUM      15.00        30.00       45.00       60.00       75.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               20.00        20.00       20.00       20.00       20.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL            1          2           3           4           5
FREQ.              0         36          45          20          11
0.002319 MINUTES FOR HISTOGRAM
```

0 1 2 Kil.

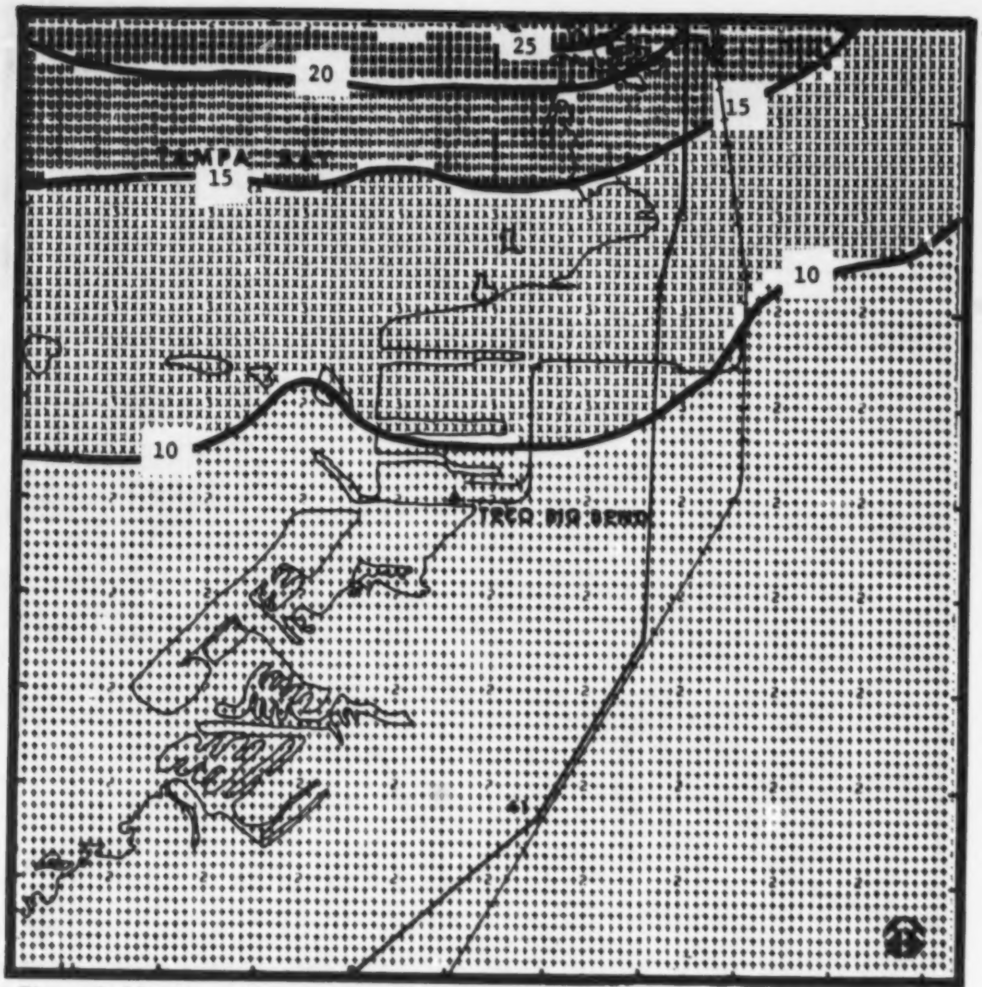


Figure 6-10. Annual average baseline TSP concentrations in the vicinity of Big Bend.

0 1 2 Kil.

```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
DER BASELINE--TSP----BIG BEND SITE


DATA VALUE EXTREMES ARE          5.40        27.20


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0       5.00      10.00      15.00      20.00      25.00
  MAXIMUM       5.00     10.00      15.00      20.00      25.00      30.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               16.67      16.67      16.67      16.67      16.67      16.67

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1          2          3          4          5          6
         ==========================================================
          ..........++++++++++XXXXXXXXXX
          ..........++++++++++XXXXXXXXXX
  SYMBOLS ....1.....++++2+++++XXXX3XXXXX
          ..........++++++++++XXXXXXXXXX
          ..........++++++++++XXXXXXXXXX
         ==========================================================
  FREQ.         0         73         31          9          5          3
 0.004469 MINUTES FOR HISTOGRAM
```

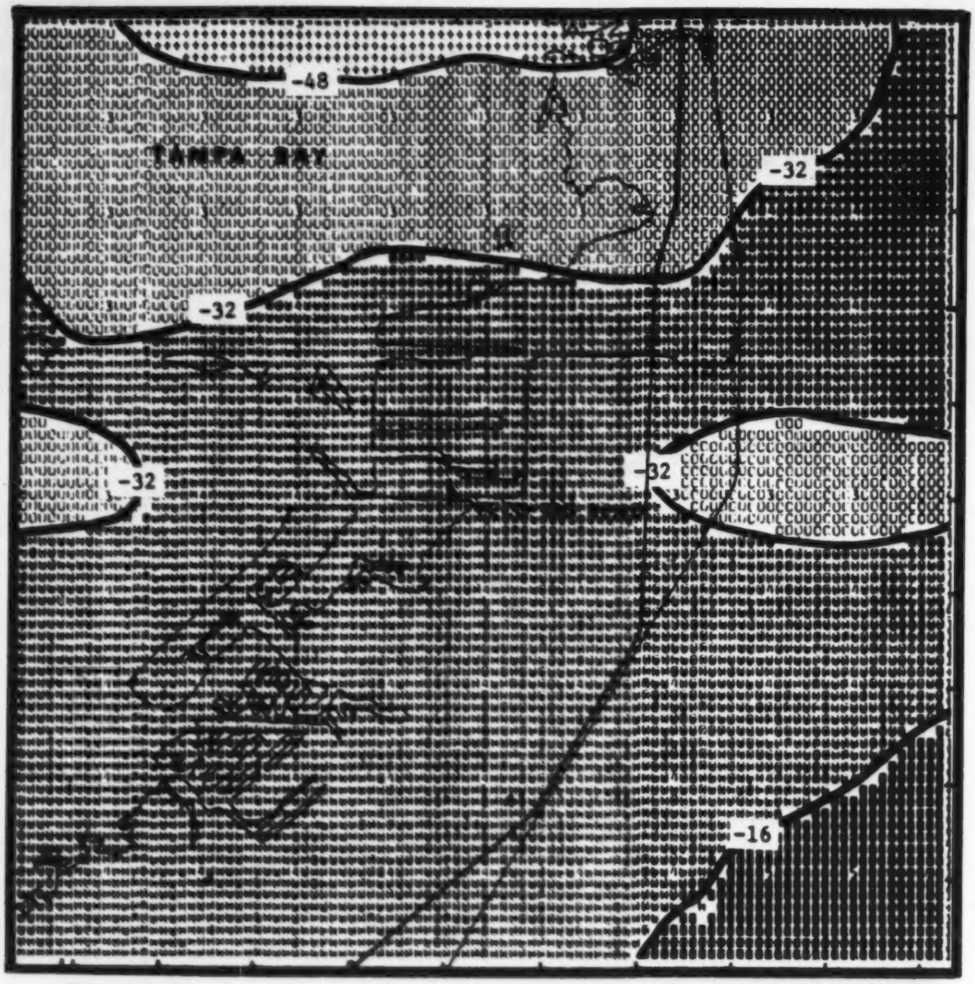


Figure 6-11. Spatial annual SO_2 increment consumption in the Big Bend area.

```
TECU BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
PER PSD INCREMENT CONSUMPTION---SO2---BIG BEND SITE


DATA VALUE EXTREMES ARE        -55.50      -13.10


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      (MAXIMUM INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM     -80.00     -64.00     -48.00     -32.00     -16.00
  MAXIMUM     -64.00     -48.00     -32.00     -16.00       0.0

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              20.00      20.00      20.00      20.00      20.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL           1          2          3          4          5

  SYMBOLS         1          2          3          4          5

  FREQ.           0          5         31         77          8
 0.007503 MINUTES FOR HISTOGRAM
```

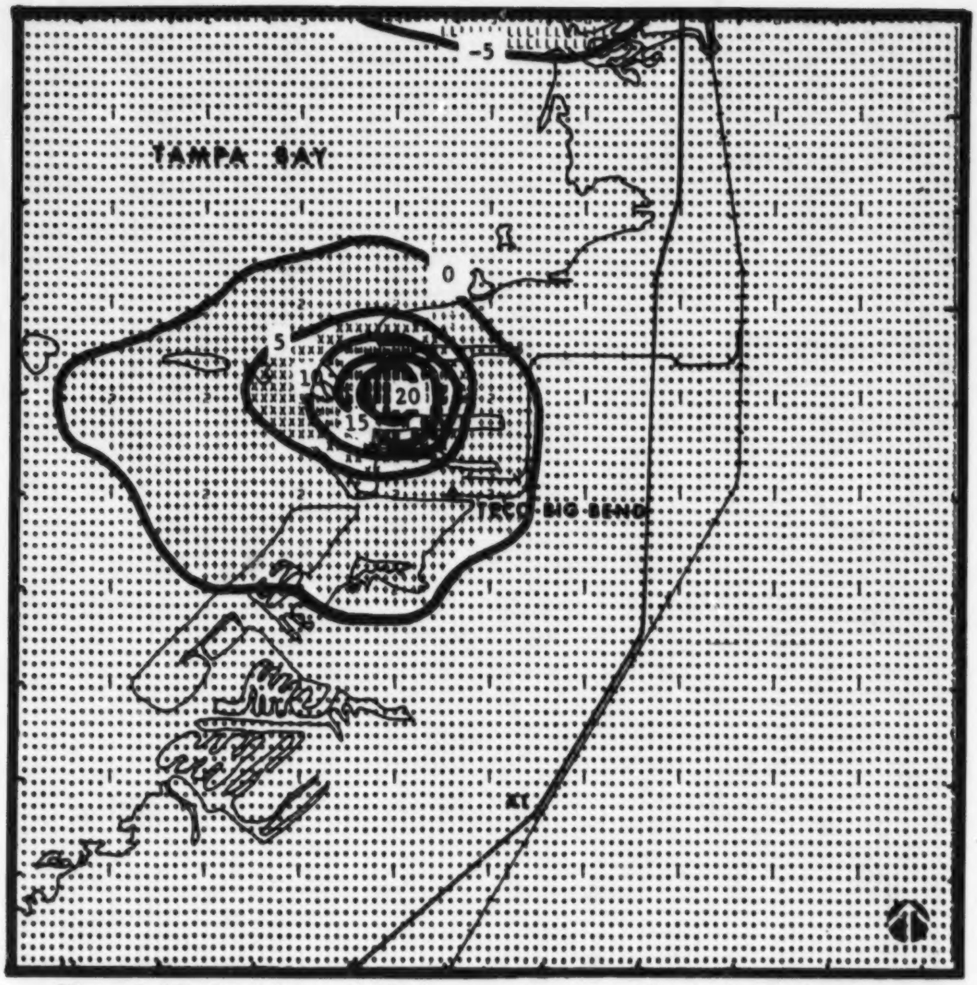
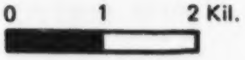
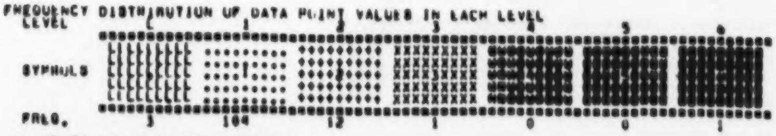


Figure 6-12. Spatial annual TSP increment consumption in the Big Bend area.



```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
DER PSD INCREMENT CONSUMPTION---TSP---BIG BEND SITE


DATA VALUE EXTREMES ARE        -6.10      24.00


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
         ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

   MINIMUM       BELOW     -5.00      0.0      5.00     10.00     15.00     20.00
   MAXIMUM       -5.00      0.0      5.00     10.00     15.00     20.00     25.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                         16.67     16.67     16.67     16.67     16.67     16.67

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL           0         1         2         3         4         5         6
```



```
  FREQ.           3       104        12         1         0         0         1
0.005475 MINUTES FOR HISTOGRAM
```

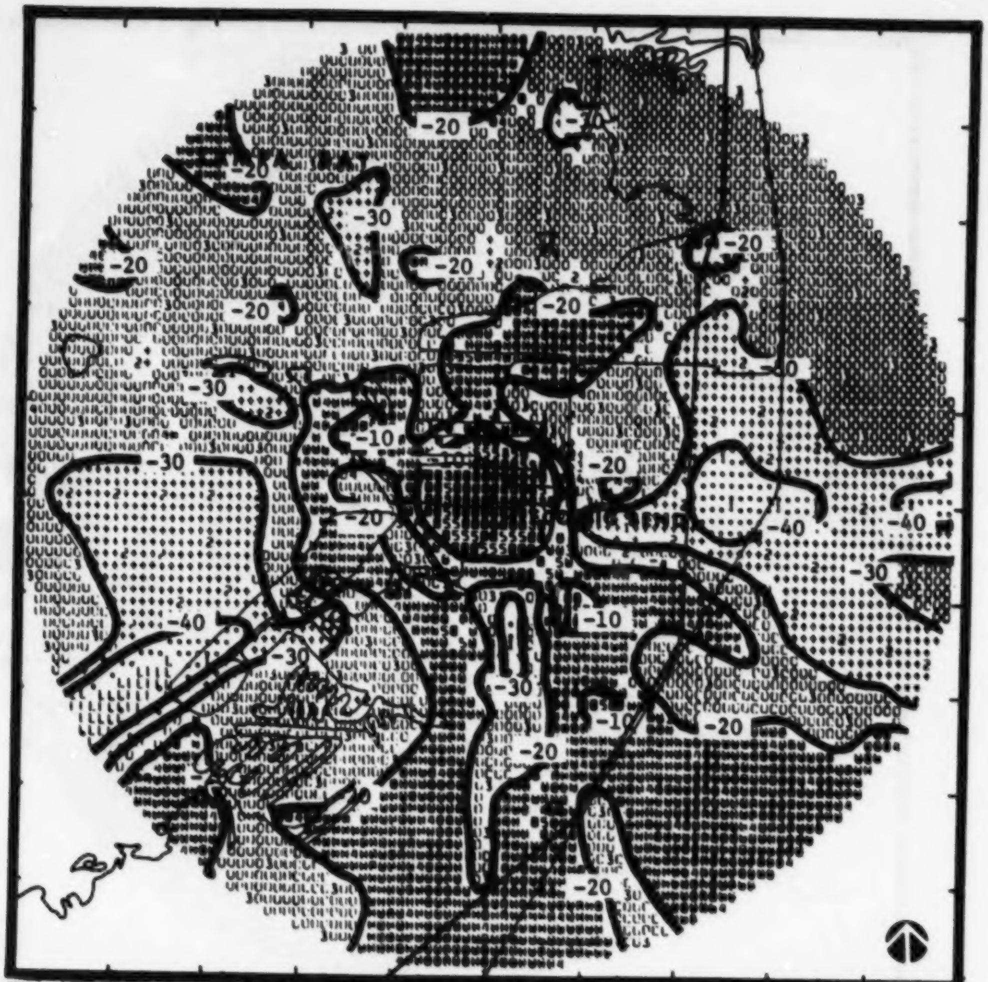

TAMPA BAY
-20
-30
-20
-30
-20
-20
-20
-20
-30
-10
-20
-30
-20
-40
-20
BIG BEND
-40
-30
-10
-40
-30
-30
-10
-20
-20
-20
0 1 2 Kil.

Figure 6-13. Spatial 24-hour SO_2 increment consumption attributable to the Big Bend facility.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU.
SO2 24-HR INCREMENT CONSUMPTION

DATA VALUE EXTREMES ARE       -60.50       0.0

TOTAL SUPERIMPOSED DATA POINTS IS      14.  THESE OCCUR IN   7 LOCATIONS.

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM     BELOW     -50.00    -40.00    -30.00    -20.00    -10.00
  MAXIMUM    -50.00     -40.00    -30.00    -20.00    -10.00      0.0

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

                     20.00     20.00     20.00     20.00     20.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL        0          1          2          3          4          5
          *****************************************************************
          LLLLLLLLL  .........  +++++++++  OOOOOOOOO  [illegible]  [illegible]
 SYMBOLS  LLLLLLLLL  ....1....  ++++2++++  OOOO3OOOO
          LLLLLLLLL  .........  +++++++++  OOOOOOOOO
          LLLLLLLLL  .........  +++++++++  OOOOOOOOO
          *****************************************************************
  FREQ.        3         12         51        149         47         48
0.000766 MINUTES FOR HISTOGRAM
```

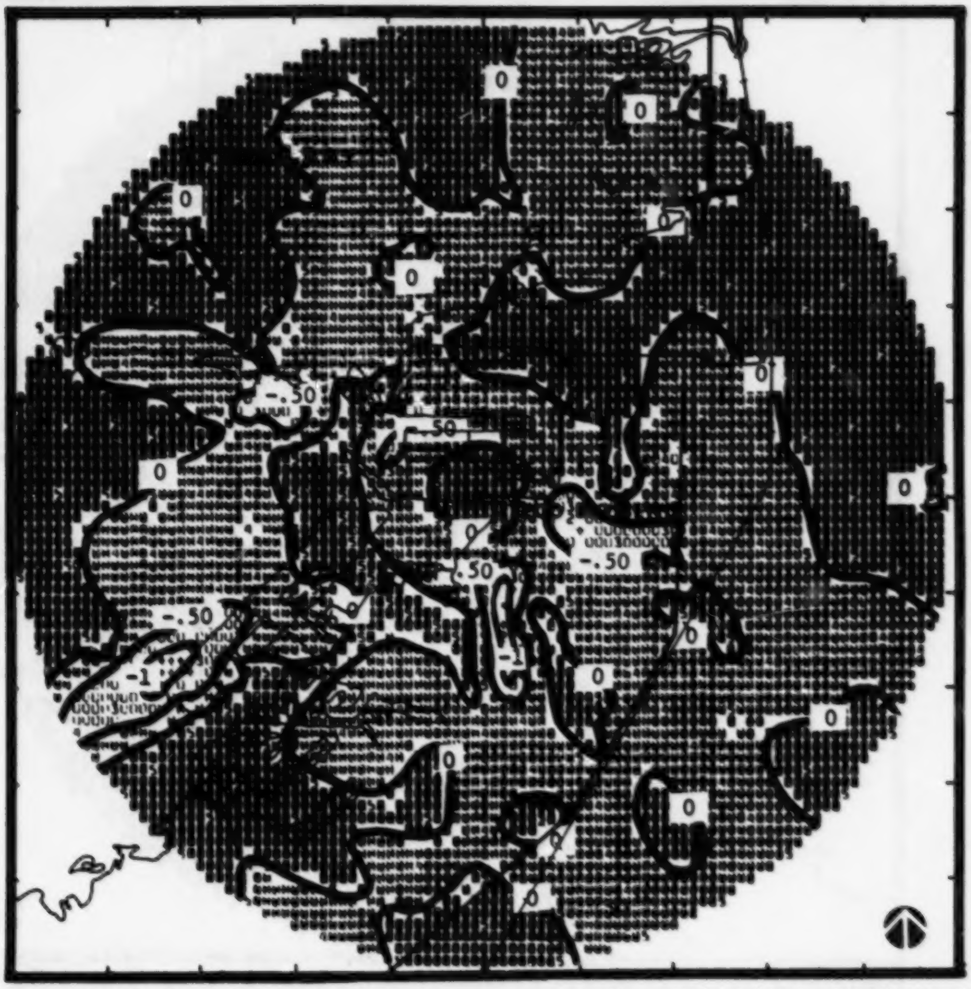
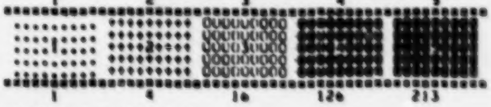


Figure 6-14. Spatial 24-hour TSP increment consumption attributable to the Big Bend facility.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU. M
TSP 24-HR INCREMENT CONSUMPTION


DATA VALUE EXTREMES ARE        -1.60        0.30

TOTAL SUPERIMPOSED DATA POINTS IS      14.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
         ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      -2.00     -1.50     -1.00     -0.50      0.0
  MAXIMUM      -1.50     -1.00     -0.50      0.0       0.50

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               20.00     20.00     20.00     20.00     20.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL           1         2         3         4         5
```



```
  FREQ.           1         4         16       126       213
 0.003249 MINUTES FOR HISTOGRAM
```

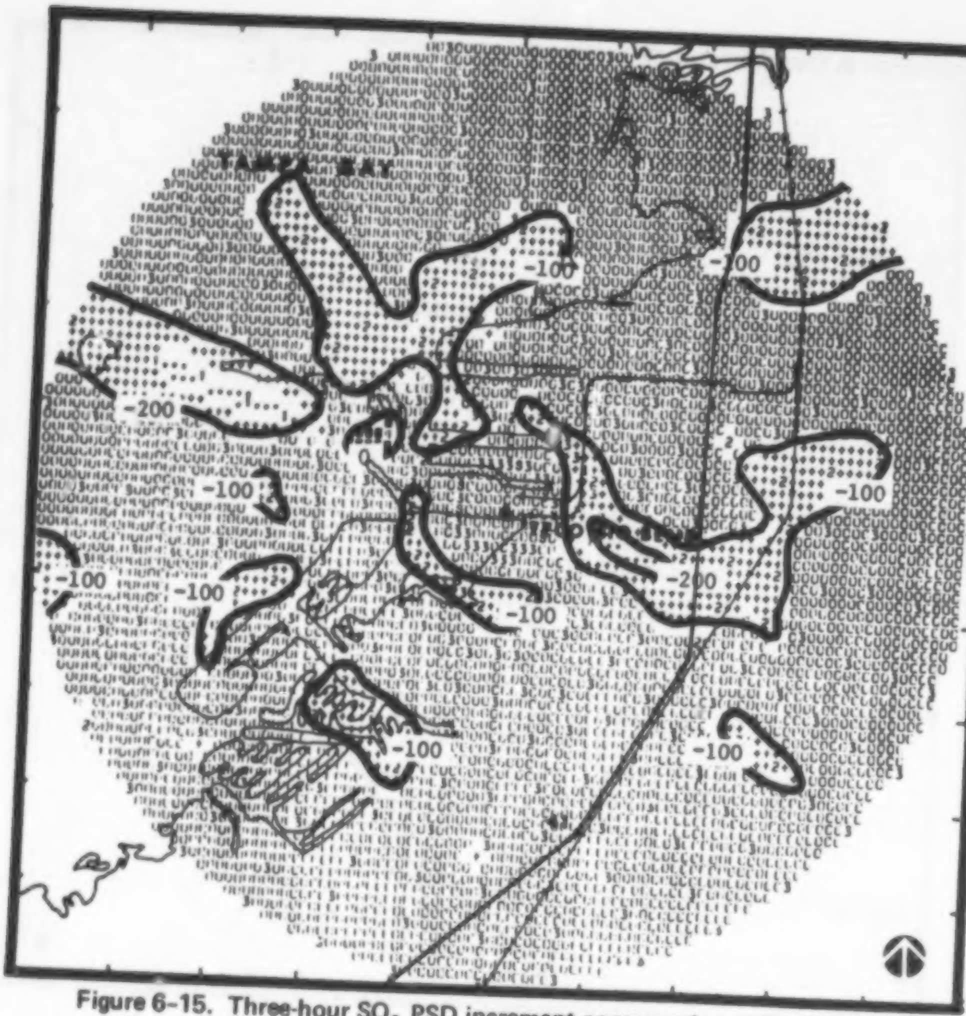
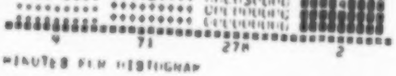

TAMPA BAY
-100
-100
-200
-100
-100
-100
-100
-200
-100
-100
-100
-100
0
1
2 Kil.

Figure 6-15. Three-hour SO_2 PSD increment consumption at Big Bend.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST  3-HOUR CONCENTRATIONS, UG/CU. M
SO2  3-HR INCREMENT CONSUMPTION


DATA VALUE EXTREMES ARE      -290.90        67.70

TOTAL SUPERIMPOSED DATA POINTS IS       19.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM   -300.00   -200.00   -100.00      0.0
 MAXIMUM   -200.00   -100.00      0.0     100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

            25.00     25.00     25.00     25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1         2         3         4
```


SYMBOLS
1
2
3

```
FREQ.           9        71       278         2
0.001790 MINUTES FOR HISTOGRAM
```

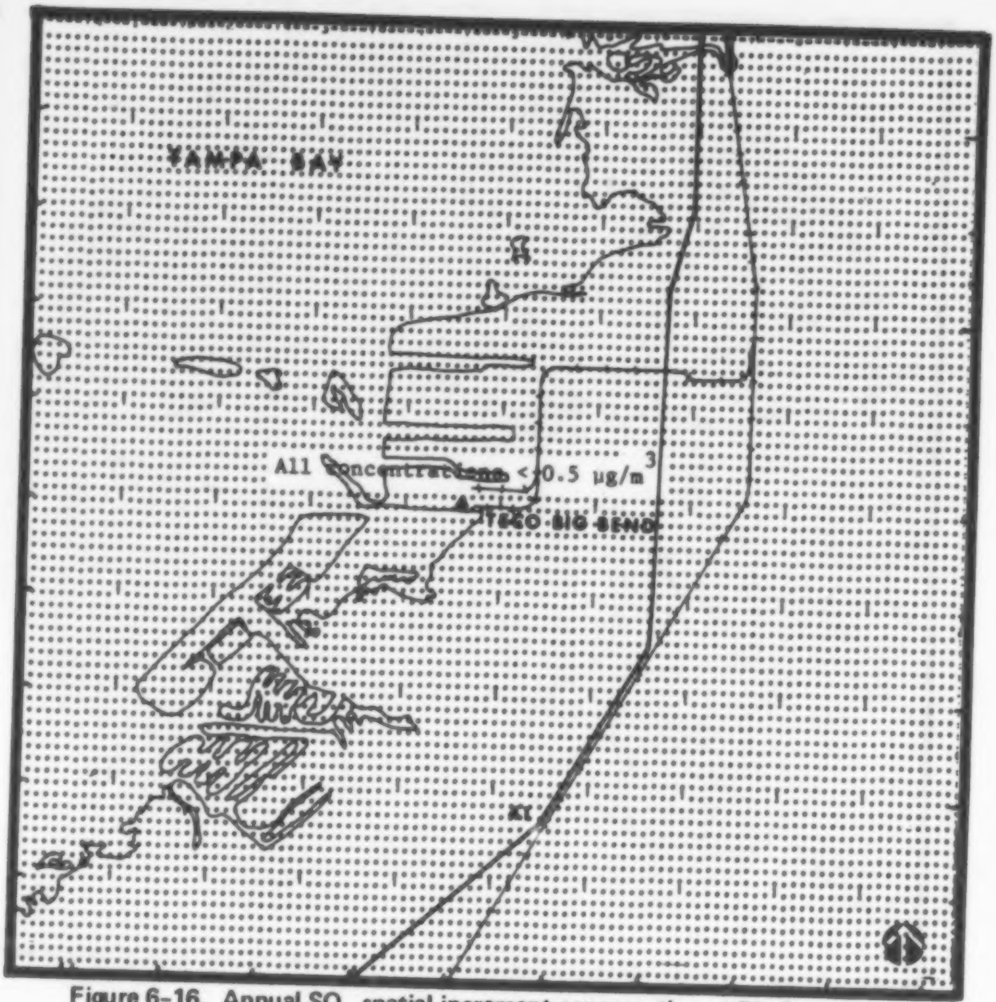
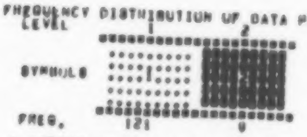


Figure 6-16. Annual SO_2 spatial increment consumption at Big Bend.

0 1 2 Kil.

```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
EPA PSD INCREMENT CONSUMPTION---SO2---BIG BEND SITE


DATA VALUE EXTREMES ARE          -0.00       -0.10


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM     -5.00      0.0
  MAXIMUM      0.0       5.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             50.00     50.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
```



```
0.005333 MINUTES FOR HISTOGRAM
```

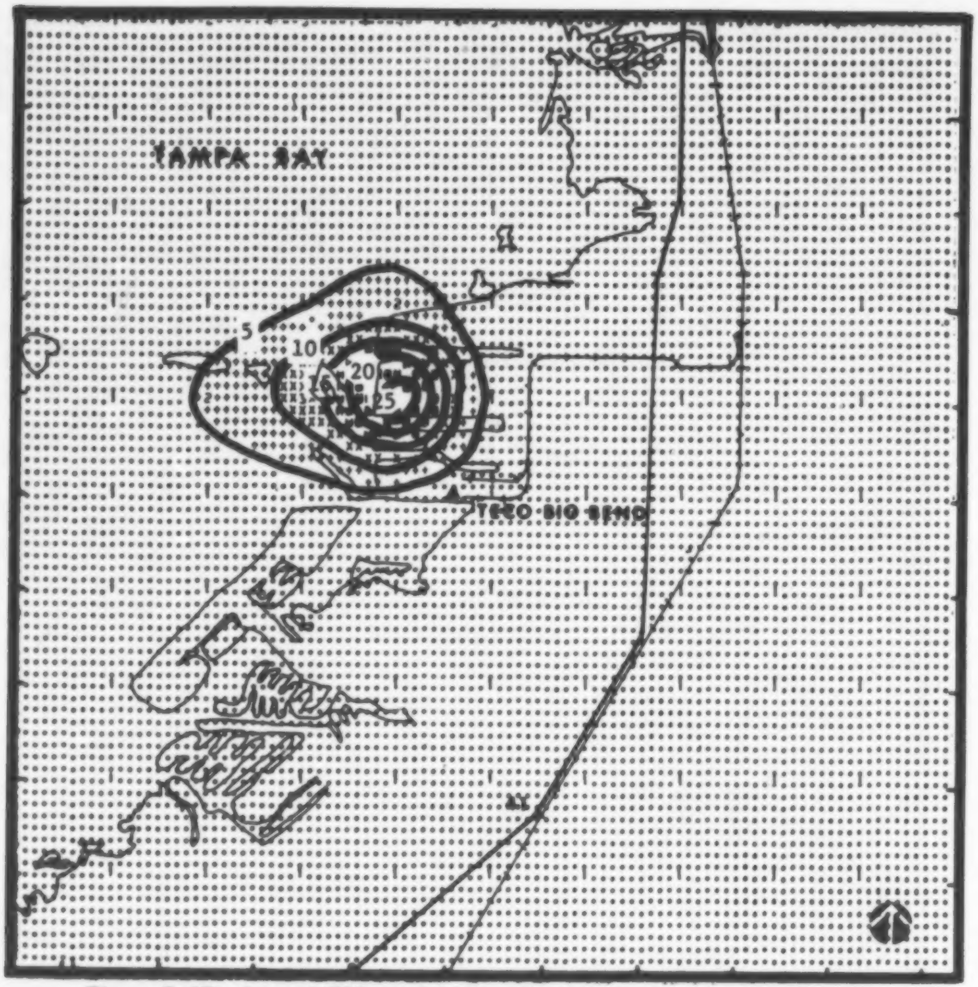


Figure 6-17. Annual TSP spatial increment consumption at Big Bend.

0 1 2 Kil.

```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
EPA PROJECTED CONCENTRATIONS DUE TO NEW AND MODIFIED SOURCES--TSP--HIG H


DATA VALUE EXTREMES ARE          1.20       26.70


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0       5.00      10.00      15.00      20.00      25.00
  MAXIMUM      5.00     10.00      15.00      20.00      25.00      30.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              16.67     16.67      16.67      16.67      16.67      16.67

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL         1         2          3          4          5          6
        ***********************************************************************
         ..........  +++++++++  XXXXXXXXX  OOOOOOOOO  #########  #########
 SYMBOLS ....1.....  ++++2++++  XXXX3XXXX  OOOO4OOOO  ####5####  ####6####
         ..........  +++++++++  XXXXXXXXX  OOOOOOOOO  #########  #########
        ***********************************************************************
 FREQ.        117         2          1          0          0          1
0.029206 MINUTES FOR HISTOGRAM
```

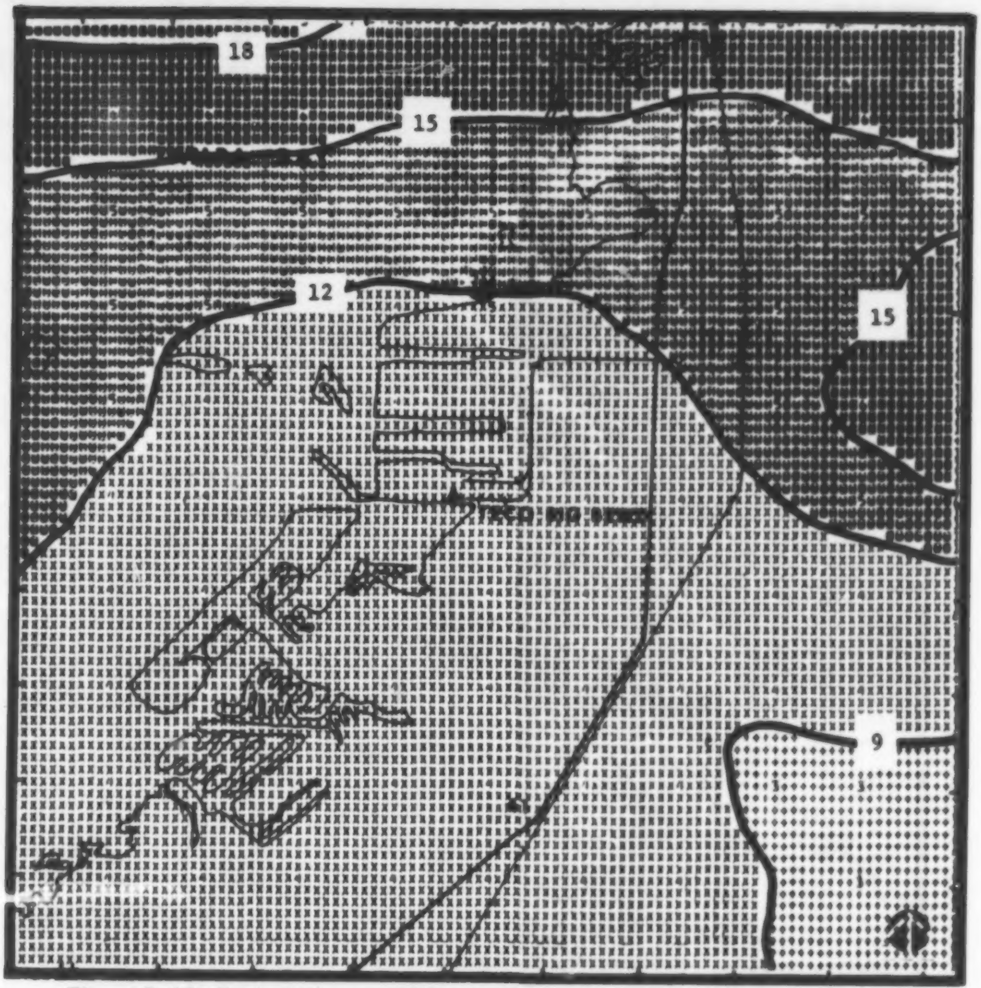
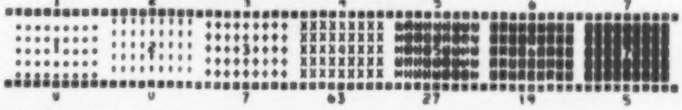


Figure 6-18. Projected annual SO_2 concentrations at the Big Bend site for all interacting emission sources.

```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
DER SO2 PROJECTED--- ALL SOURCES--BIG BEND SITE


DATA VALUE EXTREMES ARE        8.30       18.50


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
     ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0       3.00       6.00       9.00      12.00      15.00      18.00
  MAXIMUM       3.00      6.00       9.00      12.00      15.00      18.00      21.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              14.29      14.29      14.29      14.29      14.29      14.29      14.29

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1          2          3          4          5          6          7
```



```
  FREQ.         0          0          7         63         27         19          5
0.017451 MINUTES FOR HISTOGRAM
```

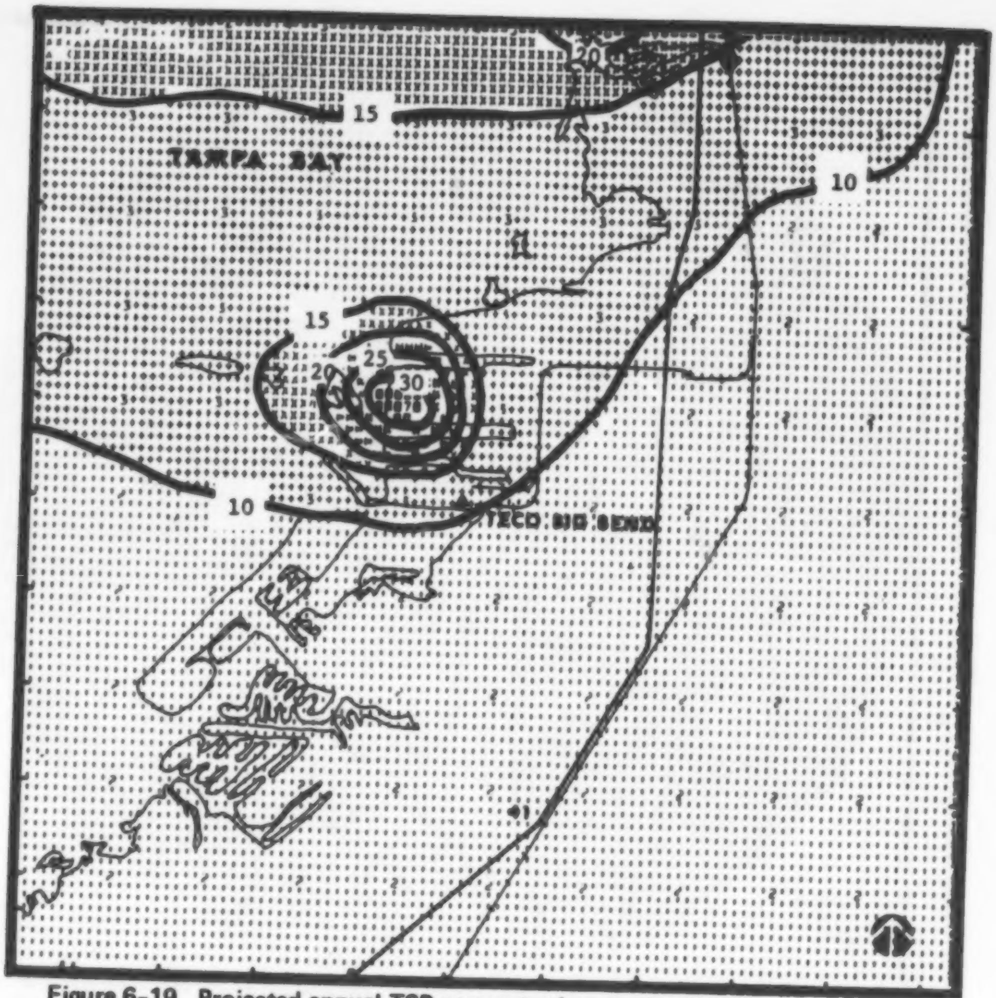


Figure 6-19. Projected annual TSP concentrations at the Big Bend site for all interacting emission sources.

```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
UER TSP PROJECTED--- ALL SOURCES--BIG BEND SITE


DATA VALUE EXTREMES ARE          5.30       34.50


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      (MAXIMUM INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM      0.0       5.00      10.00      15.00      20.00      25.00      30.00
  MAXIMUM      5.00     10.00      15.00      20.00      25.00      30.00      35.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             14.29     14.29      14.29      14.29      14.29      14.29      14.29

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1          2          3          4          5          6          7
SYMBOLS
  FREQ.          0         75         34          4          2          0          1
0.002699 MINUTES FOR HISTOGRAM
```

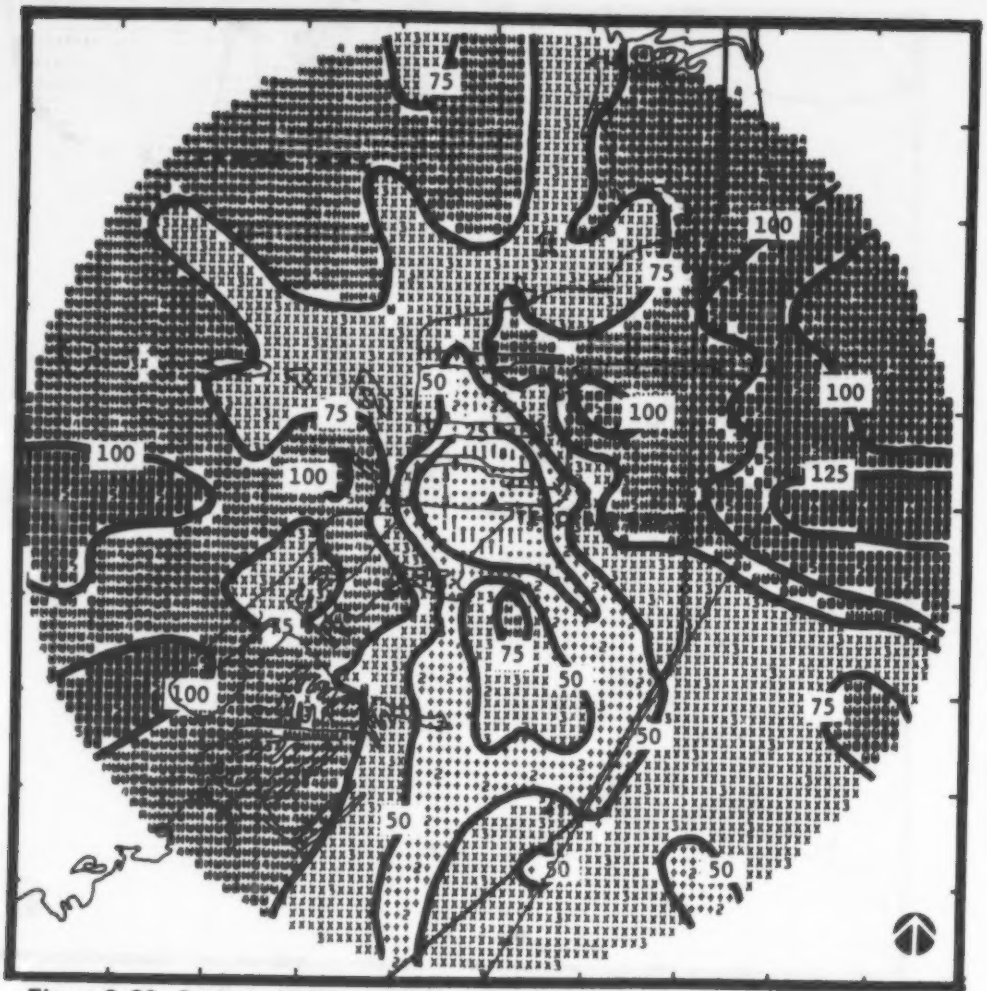
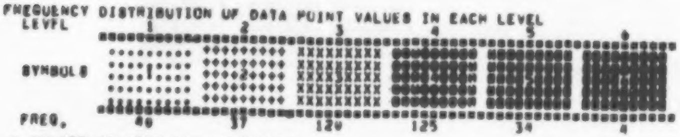


Figure 6-20. Projected 24-hour SO_2 concentrations attributable to the operation of Big Bend Units 1, 2, and 4 at 100 percent load.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU. M
SO2 24-HOUR COMPOSITE PROJECTED CONCENTRATIONS--ALL CASES

DATA VALUE EXTREMES ARE          0.0        146.30

TOTAL SUPERIMPOSED DATA POINTS IS       14.  THESE OCCUR IN   7 LOCATIONS.

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM        0.0       25.00      50.00      75.00     100.00     125.00
  MAXIMUM       25.00      50.00      75.00     100.00     125.00     150.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               16.67      16.67      16.67      16.67      16.67      16.67

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
```



```
0.006899 MINUTES FOR HISTOGRAM
```

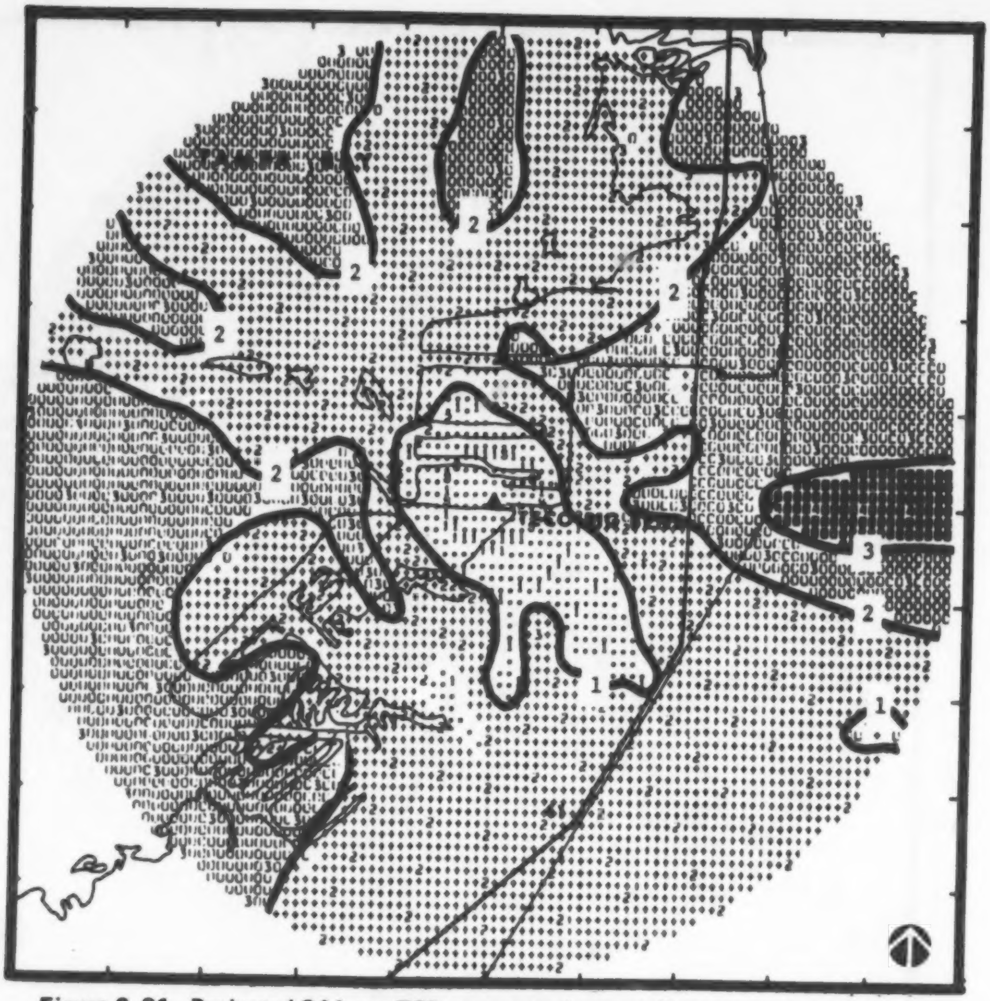


Figure 6-21. Projected 24-hour TSP concentrations attributable to the Big Bend facility.

0 1 2 Kil.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU. M
TSP 24-HOUR COMPOSITE PROJECTED CONCENTRATIONS--ALL CASES


DATA VALUE EXTREMES ARE          0.0          3.00

TOTAL SUPERIMPOSED DATA POINTS IS        14.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0        1.00        2.00        3.00
  MAXIMUM       1.00       2.00        3.00        4.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              25.00      25.00       25.00       25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1          2           3           4
         ****************************************************
          ..........  ++++++++++  0000000000  ██████████
          ..........  ++++++++++  0000000000  ██████████
  SYMBOLS ....1.....  ++++2+++++  0000300000  ██████████
          ..........  ++++++++++  0000000000  ██████████
          ..........  ++++++++++  0000000000  ██████████
         ****************************************************
  FREQ.      56         170         123          5
 0.002414 MINUTES FOR HISTOGRAM
```

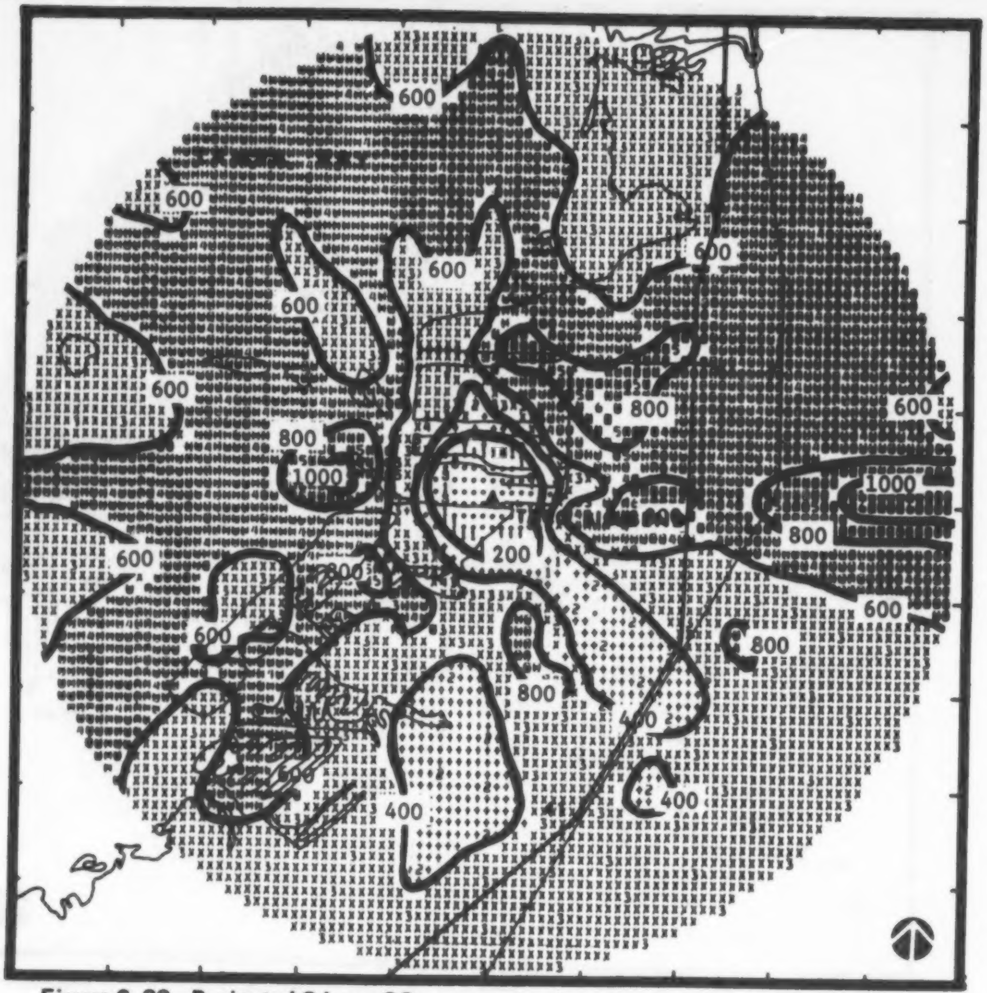

600
600
600
600
600
600
600
600
600
600
600
800
1000
800
1000
200
800
800
800
800
400
400
400
600
0 1 2 Kil.

Figure 6-22. Projected 3-hour SO_2 concentrations attributable to the Big Bend facility.

```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST  3-HOUR CONCENTRATIONS, UG/CU. M
SO2  3-HOUR COMPOSITE PROJECTED CONCENTRATIONS--ALL CASES


DATA VALUE EXTREMES ARE          0.0      1086.50

TOTAL SUPERIMPOSED DATA POINTS IS       14.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0      200.00     400.00     600.00     800.00    1000.00
  MAXIMUM    200.00      400.00     600.00     800.00    1000.00    1200.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             16.67     16.67      16.67      16.67      16.67      16.67

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1          2          3          4          5          6
         ====================================================================
             ........  +++++++++  XXXXXXXXX  █████████  █████████  █████████
  SYMBOLS    ....1...  ++++2++++  XXXX3XXXX  ████4████  ████5████  ████6████
             ........  +++++++++  XXXXXXXXX  █████████  █████████  █████████
         ====================================================================
  FREQ.         38         25        138        133         18          8
0.002039 MINUTES FOR HISTOGRAM
```

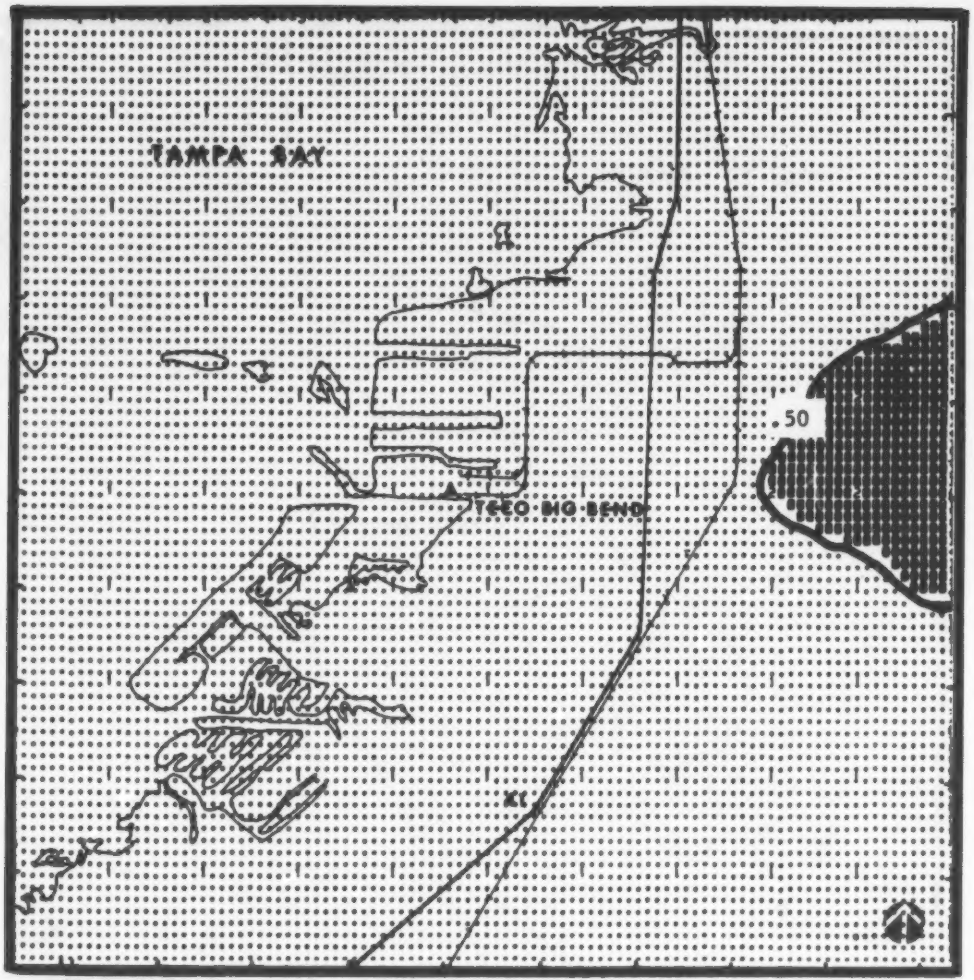
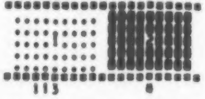


Figure 6-23. Annual average SO_2 concentrations resulting from the operation of Big Bend Unit 4 without Unit 3.

```
TECO BIG BEND 4 PSD
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
BIG BEND UNIT 4 ONLY--SO2


DATA VALUE EXTREMES ARE         0.0         1.00


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0       0.50
  MAXIMUM       0.50      1.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             50.00     50.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL            1          2
```



```
 SYMBOLS

 FREQ.        113         8
0.003771 MINUTES FOR HISTOGRAM
```

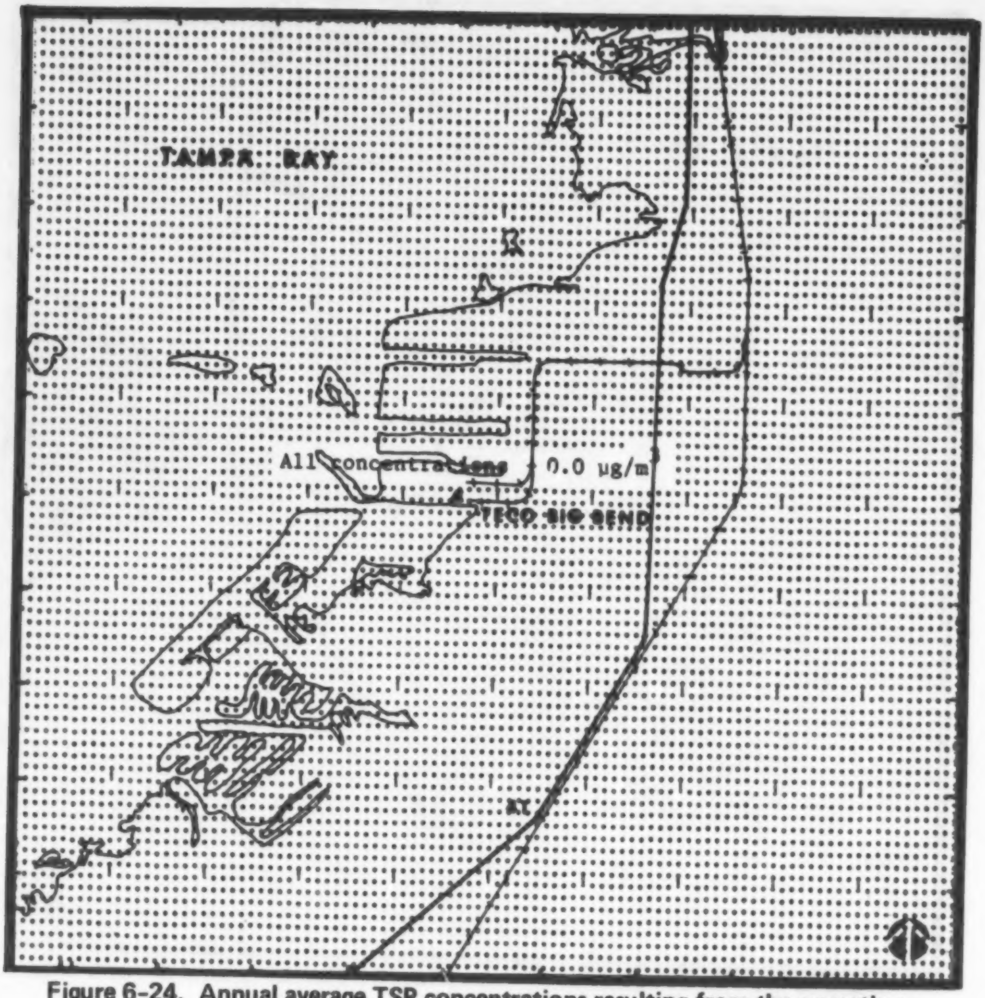

TAMPA BAY
All concentrations = 0.0 µg/m³
TECO BIG BEND
0 1 2 Kil.

Figure 6-24. Annual average TSP concentrations resulting from the operation of Big Bend Unit 4 without Unit 3.

```
TECO BIG BEND 4 TSP
ANNUAL AVERAGED CONCENTRATIONS (UG/CU. M)
BIG BEND UNIT 4 ONLY--TSP


DATA VALUE EXTREMES ARE          0.0          0.0


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0
  MAXIMUM       1.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

           100.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL        1
        ●●●●●●●●●●●
         ·········
  SYMBOLS ····1····
         ····1····
         ·········
         ·········
        ●●●●●●●●●●●
 FREQ.     121
0.002311 MINUTES FOR HISTOGRAM
```

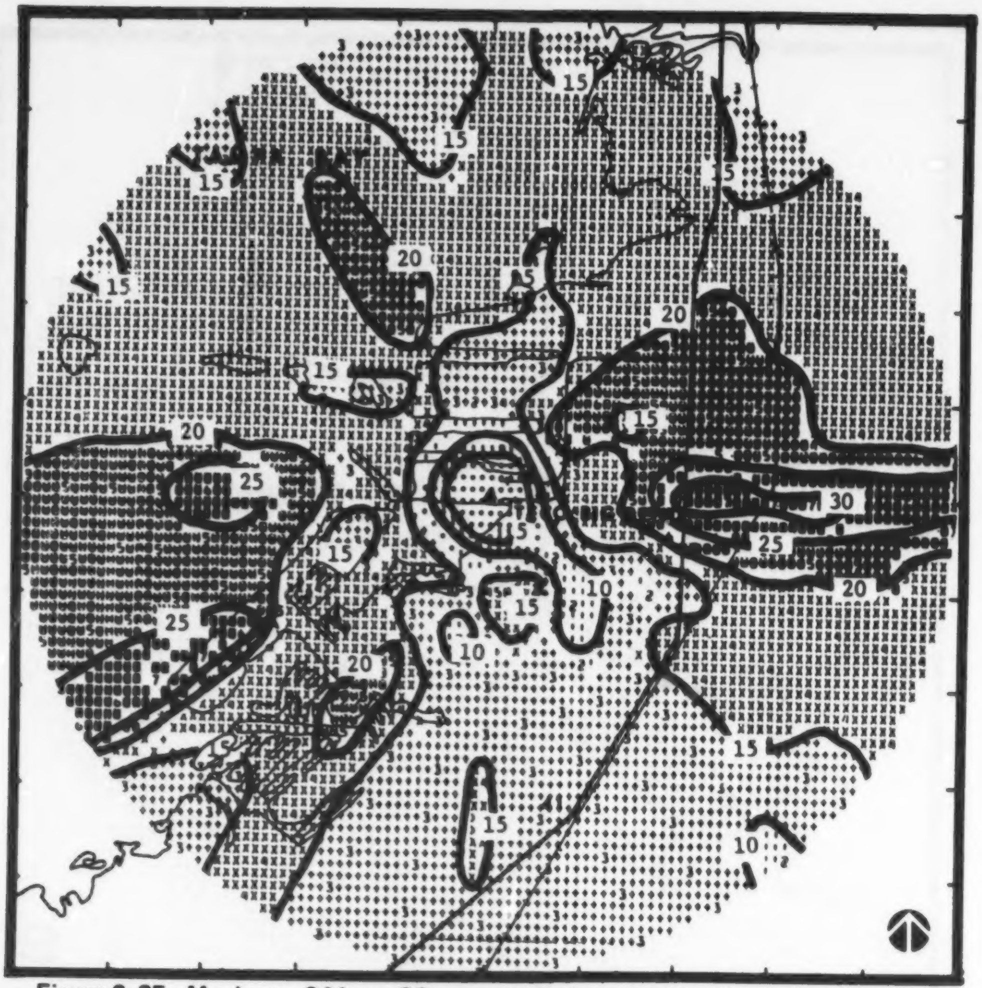
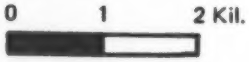
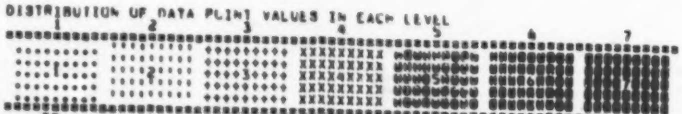


Figure 6-25. Maximum 24-hour SO_2 concentrations resulting from the operation of Big Bend Unit 4 without Unit 3.



```
TECO BIG BEND ONLY
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU. M
SO2 24-HOUR PROJECTED CONCENTRATIONS--UNIT 4 ONLY


DATA VALUE EXTREMES ARE         0.0        34.10

TOTAL SUPERIMPOSED DATA POINTS IS       14.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0       5.00      10.00      15.00      20.00      25.00      30.00
  MAXIMUM       5.00     10.00      15.00      20.00      25.00      30.00      35.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               14.29     14.29      14.29      14.29      14.29      14.29      14.29

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
 LEVEL          1          2          3          4          5          6          7

 SYMBOLS

 FREQ.          37         11         93        150         50         12          7
0.002246 MINUTES FOR HISTOGRAM
```



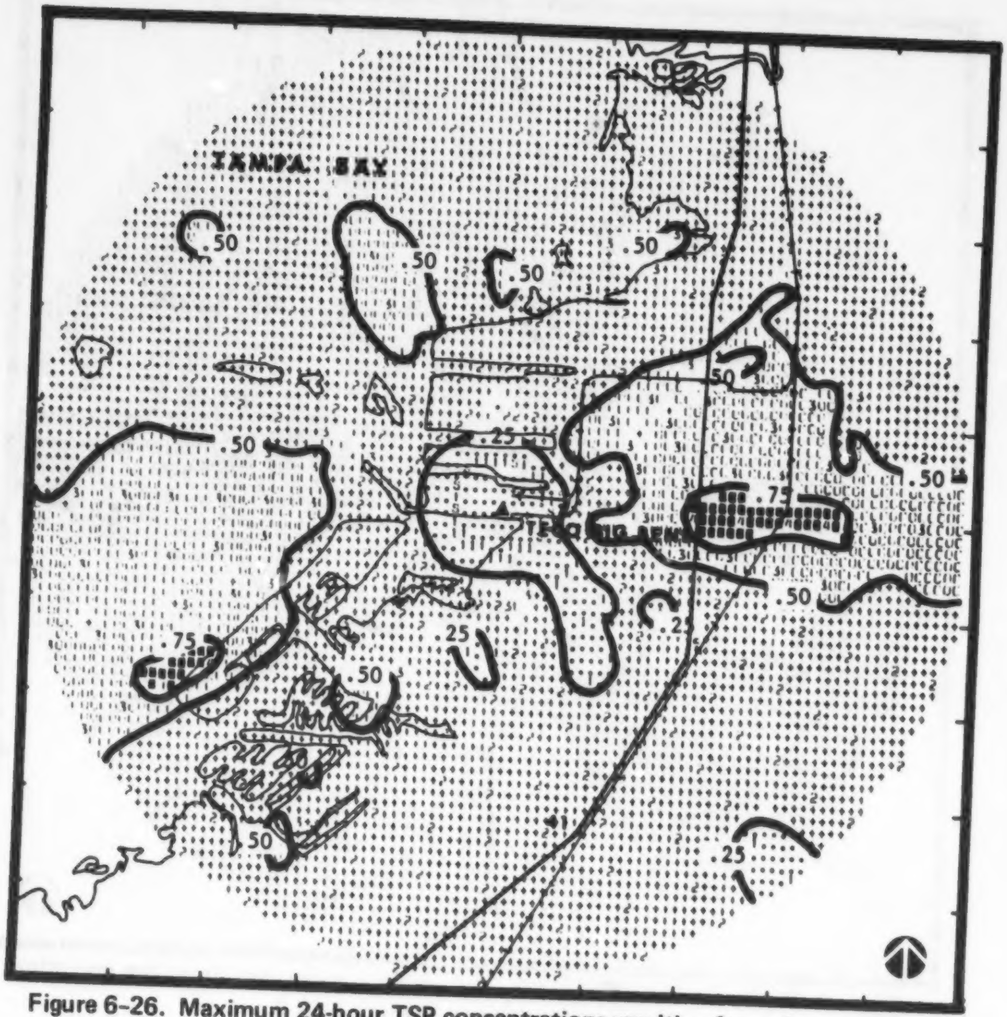
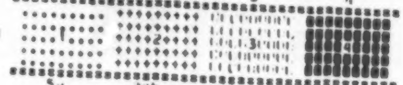


Figure 6-26. Maximum 24-hour TSP concentrations resulting from the operation of Big Bend Unit 4 without Unit 3.

```
HIGHEST,SECOND-HIGHEST 24-HOUR CONCENTRATIONS, UG/CU. M
TSP 24-HOUR PROJECTED CONCENTRATIONS--UNIT 4 ONLY


DATA VALUE EXTREMES ARE            0.0          0.90

TOTAL SUPERIMPOSED DATA POINTS IS       19.  THESE OCCUR IN   7 LOCATIONS.

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        (*MAXIMUM* INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0        0.25        0.50        0.75
  MAXIMUM       0.25       0.50        0.75        1.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              25.00      25.00      25.00      25.00

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1          2          3          4
```



```
  SYMBOLS
  FREQ.         50        205         98          7
0.002983 MINUTES FOR HISTOGRAM
```

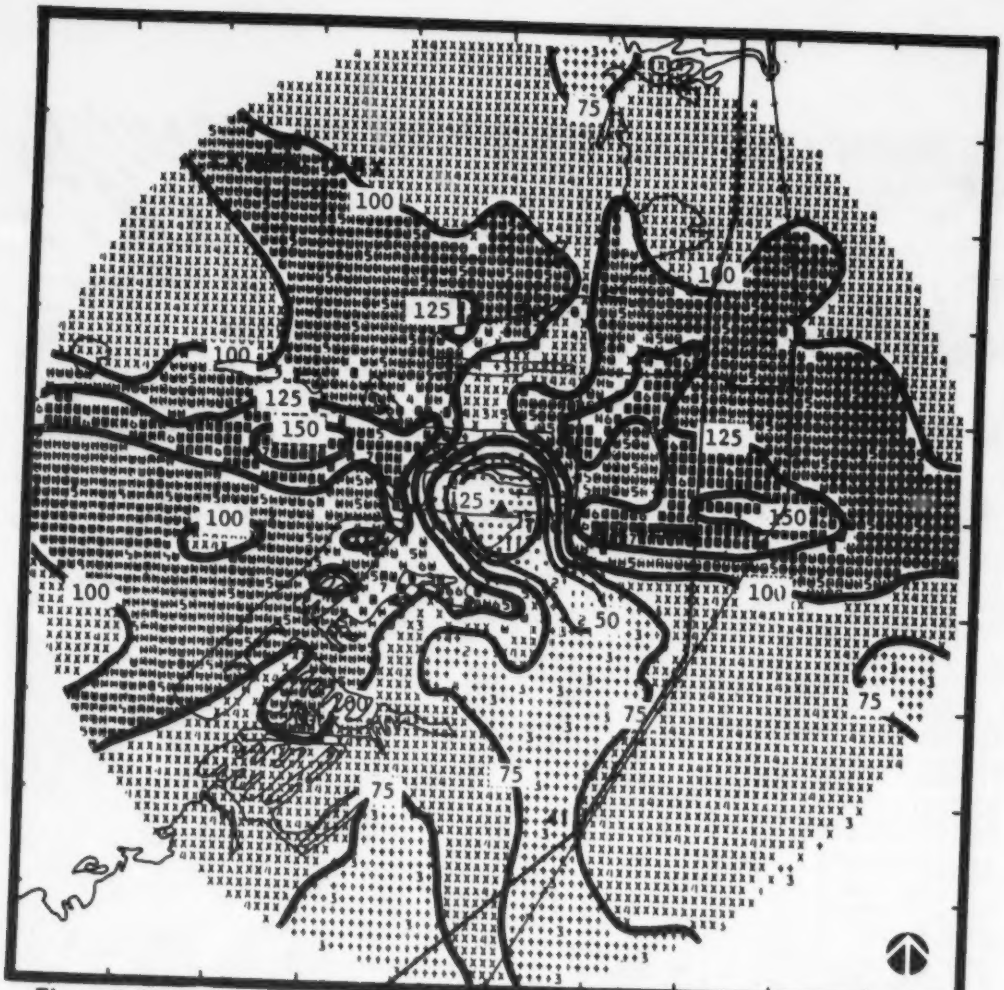
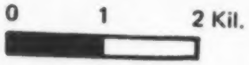
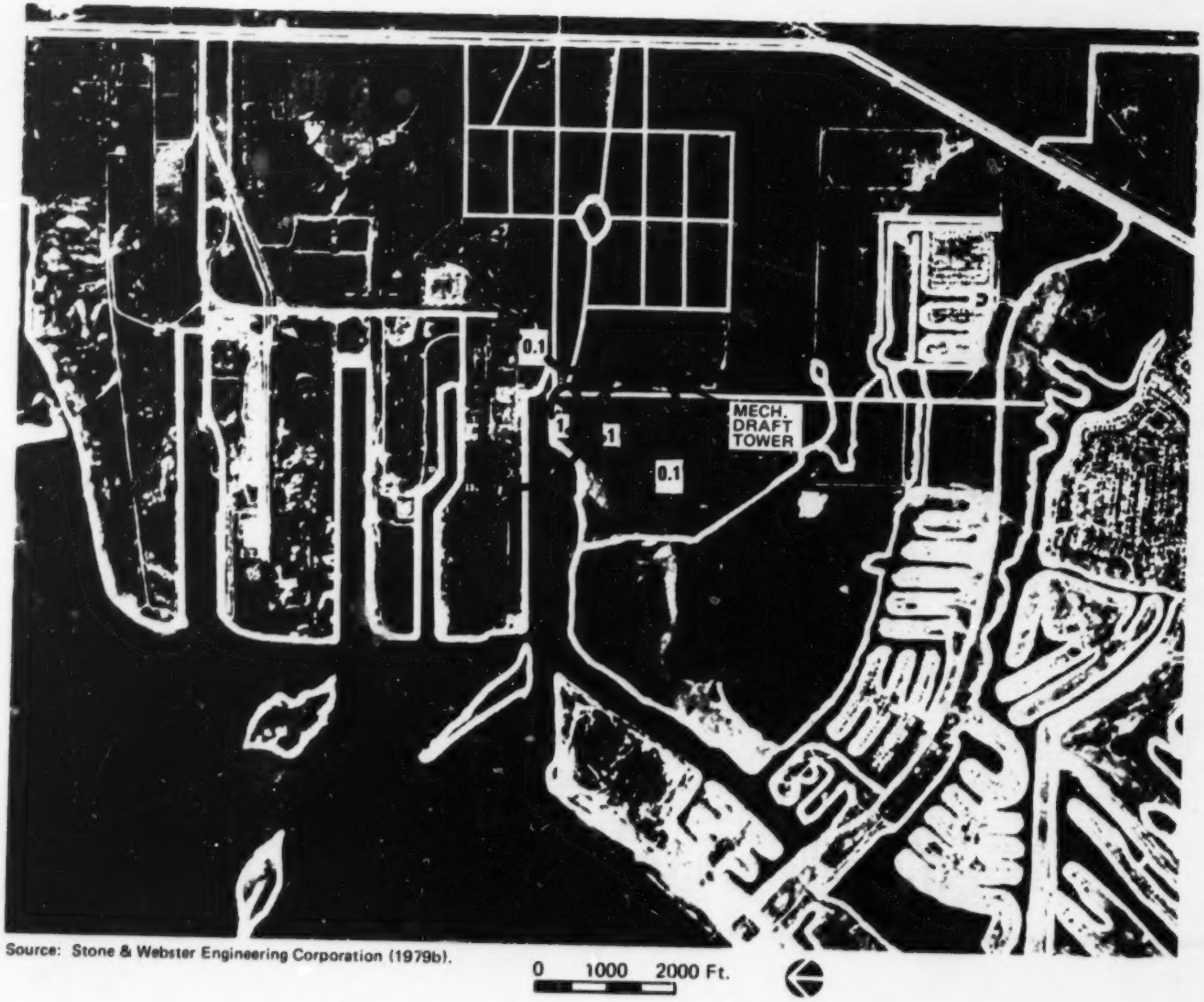


Figure 6-27. SO_2 incremental impacts of Big Bend Unit 4 at points of maximum impact and at nonattainment area boundaries.

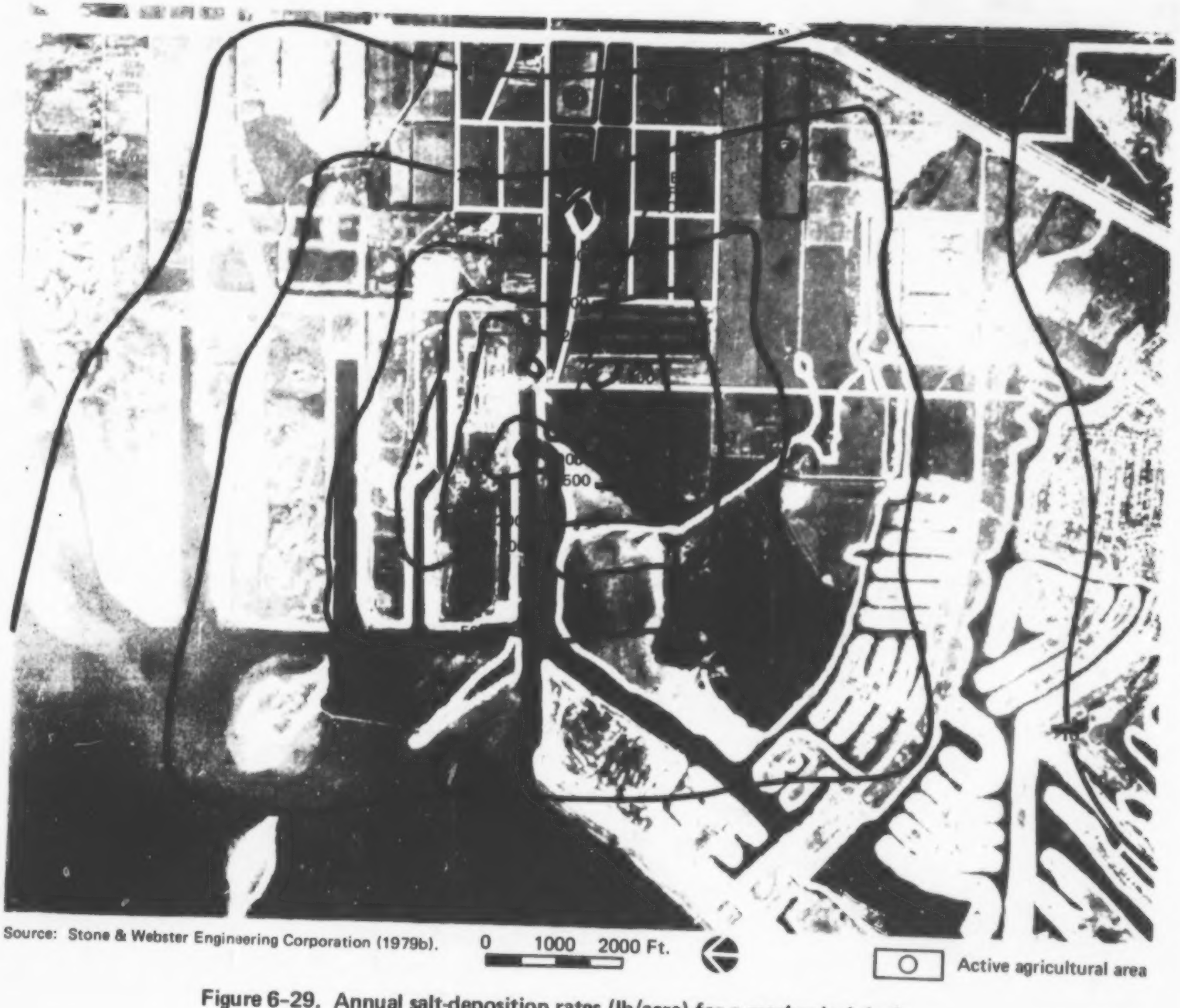


```
HIGHEST,SECOND-HIGHEST  3-HOUR CONCENTRATIONS, UG/CU. M
SO2  3-HOUR PROJECTED CONCENTRATIONS--UNIT 4 ONLY


DATA VALUE EXTREMES ARE          0.0        160.60

TOTAL SUPERIMPOSED DATA POINTS IS       14.  THESE OCCUR IN   7 LOCATIONS.


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
         ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       0.0       25.00      50.00      75.00     100.00     125.00     150.00
  MAXIMUM     25.00       50.00      75.00     100.00     125.00     150.00     175.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

             14.29      14.29      14.29      14.29      14.29      14.29      14.29

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL        1          2          3          4          5          6          7
          ======================================================================
           ..........  ''''''''''  ++++++++++  XXXXXXXXXX  MMMMMMMMMM  ●●●●●●●●●●  ●●●●●●●●●●
  SYMBOLS  ....1.....  ''''2'''''  ++++3+++++  XXXX4XXXXX  MMMM5MMMMM  ●●●●6●●●●●  ●●●●7●●●●●
           ..........  ''''''''''  ++++++++++  XXXXXXXXXX  MMMMMMMMMM  ●●●●●●●●●●  ●●●●●●●●●●
          ======================================================================
  FREQ.        30         5          41         130        102        39          7
0.002441 MINUTES FOR HISTOGRAM
```


0.1
1
1
0.1
MECH.
DRAFT
TOWER
0
1000
2000 Ft.

Source: Stone & Webster Engineering Corporation (1979b).

Figure 6-28. Percent frequency of potential ground fog resulting from the operation of a mechanical-draft cooling tower at the Big Bend Powerplant.


500
0
1000
2000 Ft.
Active agricultural area

Source: Stone & Webster Engineering Corporation (1979b).

Figure 6-29. Annual salt-deposition rates (lb/acre) for a mechanical-draft cooling tower at Big Bend Station.

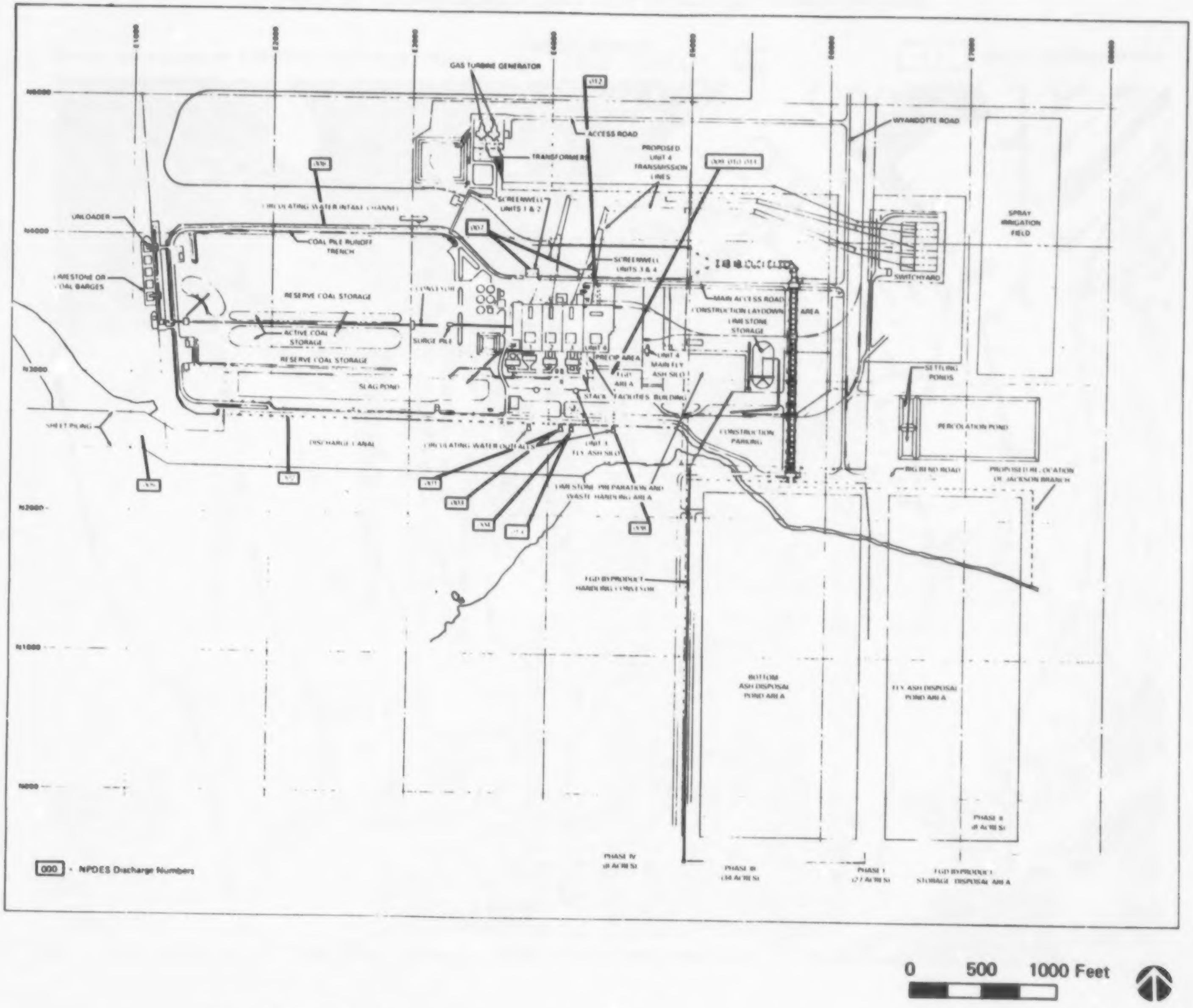

GAS TURBINE GENERATOR
012
ACCESS ROAD
TRANSFORMERS
PROPOSED UNIT 4 TRANSMISSION LINES
009 010 011
WYANDOTTE ROAD
SPRAY IRRIGATION FIELD
SWITCHYARD
CIRCULATING WATER INTAKE CHANNEL
SCREENWELL UNITS 1 & 2
007
SCREENWELL UNITS 3 & 4
UNLOADER
COAL PILE RUNOFF TRENCH
LIMESTONE OR COAL BARGES
RESERVE COAL STORAGE
CONVEYOR
MAIN ACCESS ROAD
CONSTRUCTION LAYDOWN AREA
LIMESTONE STORAGE
ACTIVE COAL STORAGE
SURGE PILE
UNIT 4
PRECIP AREA
UNIT 4 MAIN FLY ASH SILO
FGD AREA
RESERVE COAL STORAGE
SLAG POND
STACK
FACILITIES BUILDING
SETTLING PONDS
SHEET PILING
DISCHARGE CANAL
CIRCULATING WATER OUTFALLS
UNIT 3 FLY ASH SILO
CONSTRUCTION PARKING
PERCOLATION POND
BIG BEND ROAD
PROPOSED RELOCATION OF JACKSON BRANCH
LIMESTONE PREPARATION AND WASTE HANDLING AREA
FGD BYPRODUCT HANDLING CONVEYOR
BOTTOM ASH DISPOSAL POND AREA
FLY ASH DISPOSAL POND AREA
PHASE II (8 ACRES)
PHASE IV (8 ACRES)
PHASE III (34 ACRES)
PHASE I (27 ACRES)
FGD BYPRODUCT STORAGE DISPOSAL AREA
N6000
N4000
N3000
N2000
N1000
N000
E1000
E2000
E3000
E4000
E5000
E6000
E7000
E8000
000 - NPDES Discharge Numbers
0
500
1000 Feet

Figure 6-30. Liquid and gaseous emission points, Big Bend Station Unit 4.

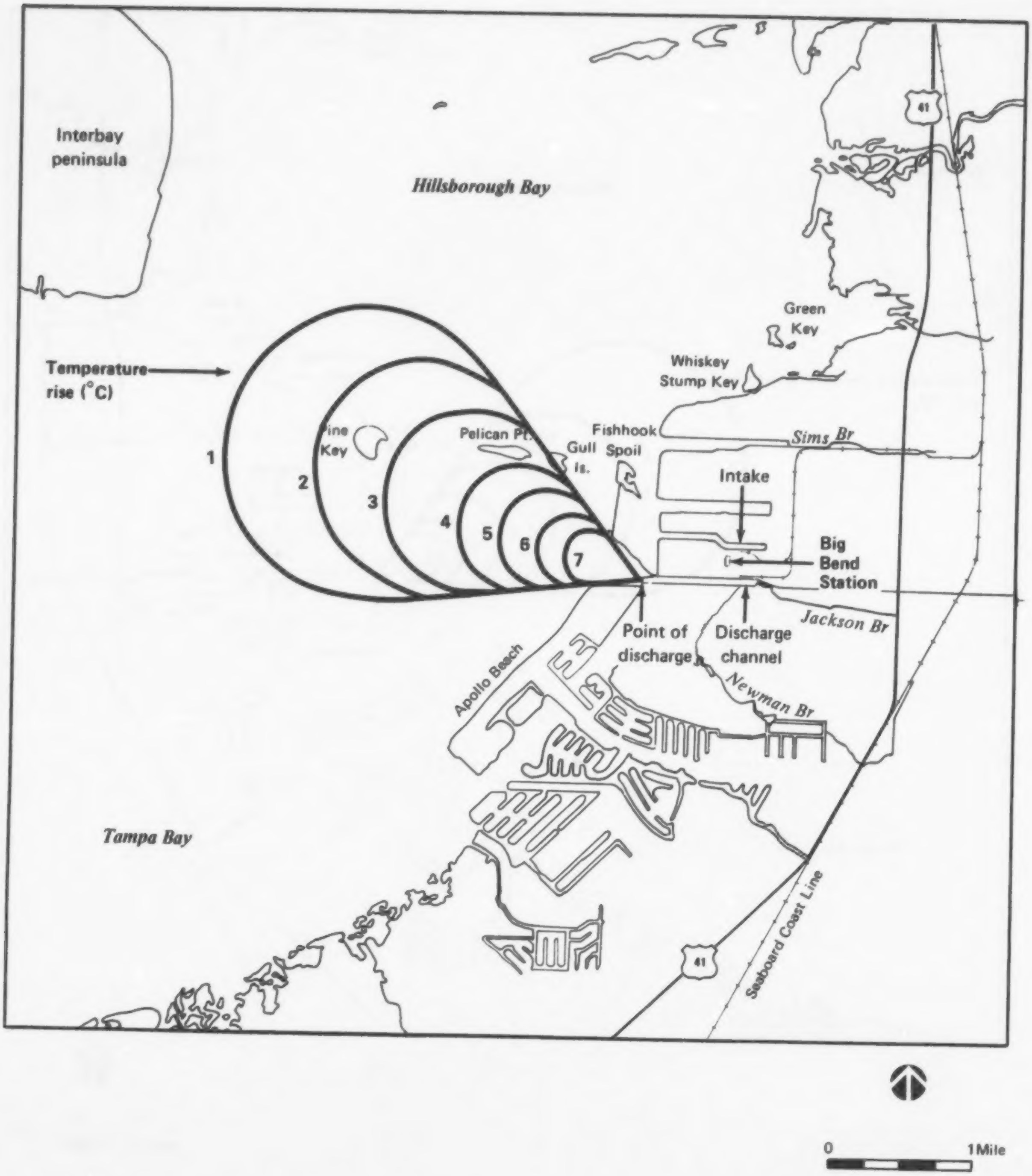

Interbay peninsula
Hillsborough Bay
Temperature rise (°C)
1
2
3
4
5
6
7
Pine Key
Pelican Pt.
Gull Is.
Fishhook Spoil
Whiskey Stump Key
Green Key
Sims Br
Intake
Big Bend Station
Jackson Br
Point of discharge
Discharge channel
Newman Br
Apollo Beach
Tampa Bay
41
Seaboard Coast Line
0
1 Mile

Figure 6-31. Isothermal contour map for three generating units operating at 100 percent load with no dilution pumps, Big Bend Station

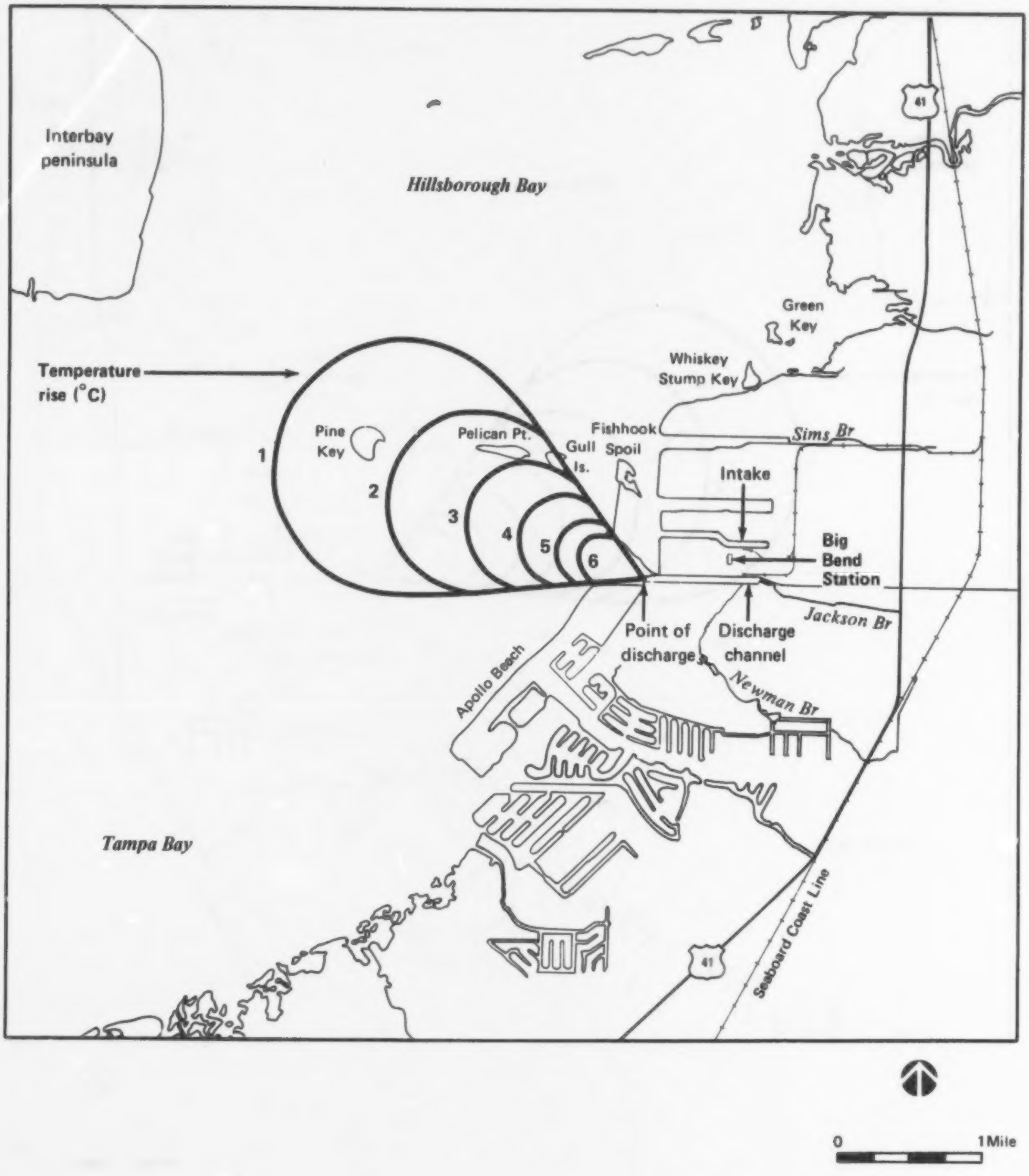

Interbay
peninsula
Hillsborough Bay
Temperature rise (°C)
1
2
3
4
5
6
Pine Key
Pelican Pt.
Gull Is.
Fishhook Spoil
Whiskey Stump Key
Green Key
Sims Br
Intake
Big Bend Station
Point of discharge
Discharge channel
Jackson Br
Newman Br
Apollo Beach
Tampa Bay
41
Seaboard Coast Line
0
1 Mile

Figure 6-32. Isothermal contour map for three generating units operating at 64 percent load with no dilution pumps, Big Bend Station.

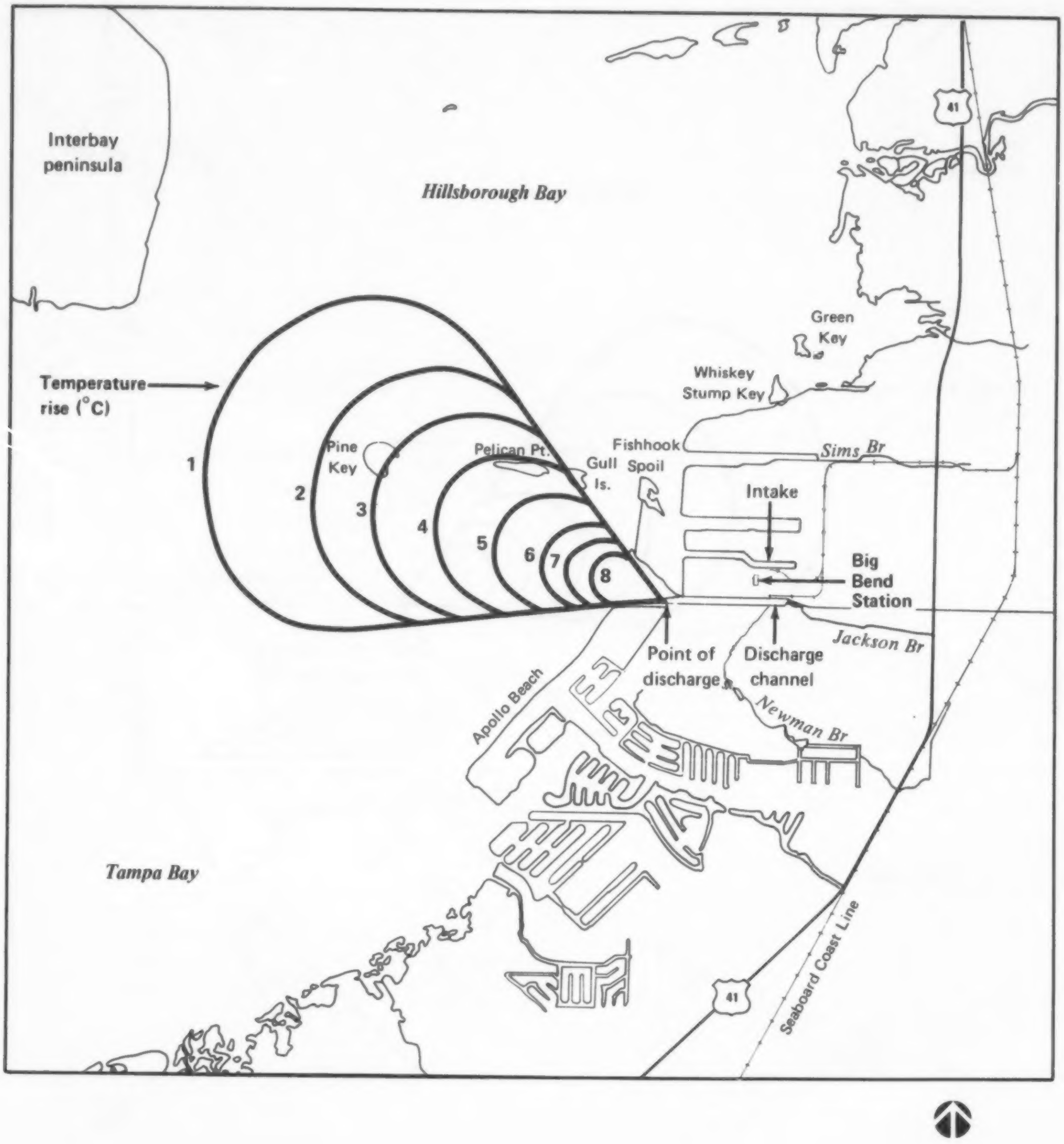
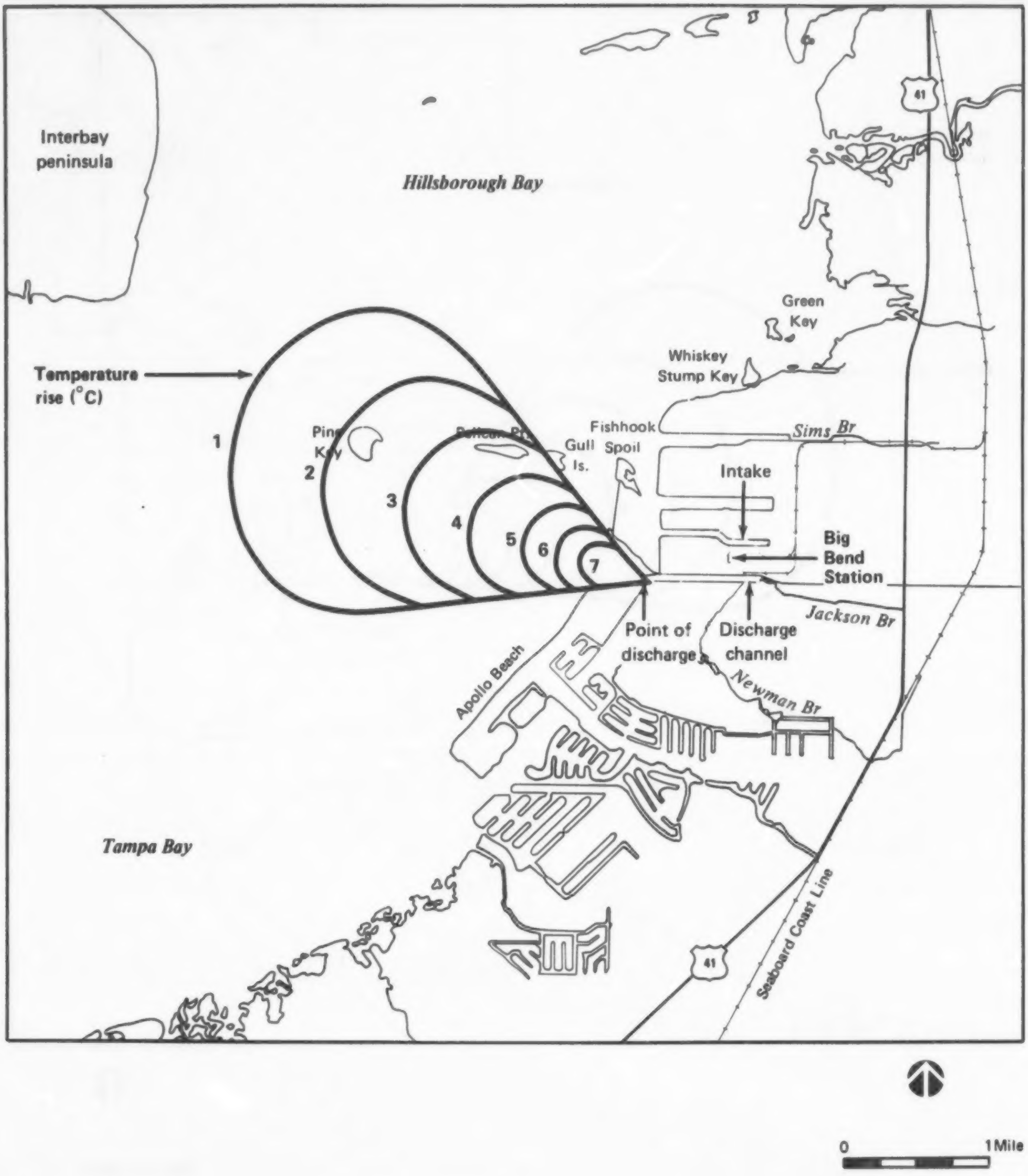
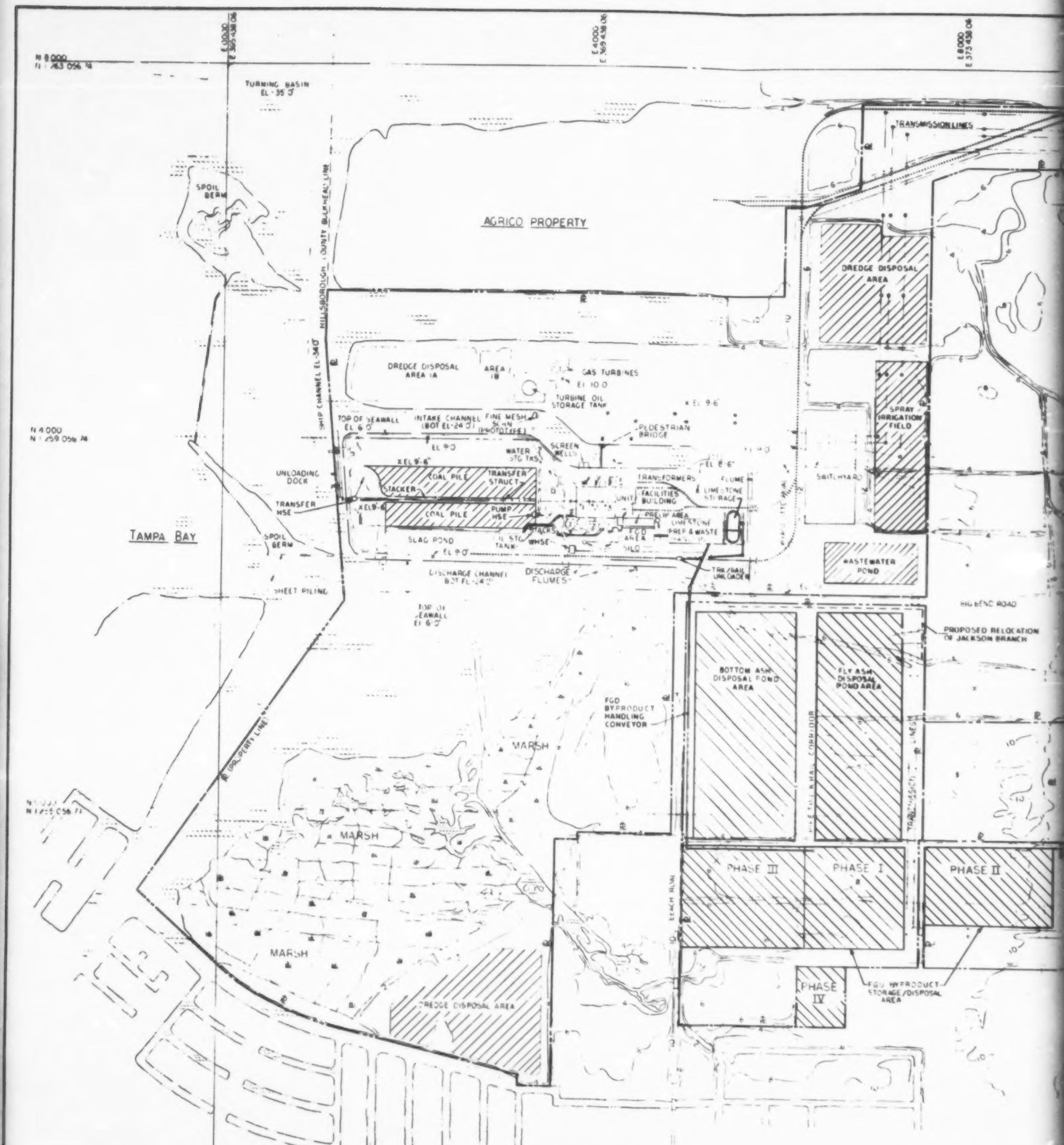

Interbay peninsula
Hillsborough Bay
41
Green Key
Whiskey Stump Key
Temperature rise (°C)
1
2
3
4
5
6
7
8
Pine Key
Pelican Pt.
Gull Is.
Fishhook Spoil
Sims Br
Intake
Big Bend Station
Point of discharge
Discharge channel
Jackson Br
Newman Br
Apollo Beach
Tampa Bay
Seaboard Coast Line
41
0
1 Mile

Figure 6-33. Isothermal contour map for four generating units operating at 100 percent load with no dilution pumps, Big Bend Station.



Interbay peninsula
Hillsborough Bay
Temperature rise (°C)
1
2
3
4
5
6
7
Pine Key
Pelican Pt
Gull Is.
Fishhook Spoil
Green Key
Whiskey Stump Key
Sims Br
Intake
Big Bend Station
Point of discharge
Discharge channel
Jackson Br
Newman Br
Apollo Beach
Tampa Bay
41
41
Seaboard Coast Line
0
1 Mile

Figure 6-34. Isothermal contour map for four generating units operating at 64 percent load with no dilution pumps, Big Bend Station.


N 8000
N 1 263 056.74
E 0.000
E 365 438.06
E 4000
E 369 438.06
E 8000
E 373 438.06
TURNING BASIN
EL -35.0'
SPOIL BERM
AGRICO PROPERTY
TRANSMISSION LINES
DREDGE DISPOSAL AREA
SHIP CHANNEL EL -34.0'
HILLSBOROUGH COUNTY BULKHEAD LINE
DREDGE DISPOSAL AREA 1A
AREA 1B
GAS TURBINES
EL 10.0
TURBINE OIL STORAGE TANK
X EL 9.6'
SPRAY IRRIGATION FIELD
N 4000
N 1 259 056.74
TOP OF SEAWALL EL 6.0'
INTAKE CHANNEL (BOT EL -24.0')
FINE MESH SCRN (PHOTOTYPE)
PEDESTRIAN BRIDGE
EL 9.0
WATER STG TKS
SCREEN WELLS
X EL 9'-6"
EL 8'-6"
UNLOADING DOCK
COAL PILE
TRANSFER STRUCT
STACKER
TRANSFORMERS
FLUME
UNIT
FACILITIES BUILDING
LIMESTONE STORAGE
SWITCHYARD
TRANSFER HSE
X EL 9'-6"
COAL PILE
PUMP HSE
PRECIP AREA
LIMESTONE PREP & WASTE HANDLING
TAMPA BAY
SPOIL BERM
SLAG POND
OIL STG TANK
STACKS
WHSE
FGD AREA
SILO
WASTEWATER POND
EL 9.0'
DISCHARGE CHANNEL BOT EL -24.0'
DISCHARGE FLUMES
TRK/RAIL UNLOADER
SHEET PILING
TOP OF SEAWALL EL 6.0'
BIG BEND ROAD
PROPOSED RELOCATION OF JACKSON BRANCH
BOTTOM ASH DISPOSAL POND AREA
FLY ASH DISPOSAL POND AREA
FGD BYPRODUCT HANDLING CONVEYOR
PIPE, TRUCK, RAIL CORRIDOR
TRANSMISSION LINES
MARSH
PROPERTY LINE
N 0.000
N 1 255 056.74
MARSH
PHASE III
PHASE I
PHASE II
BEACH ROAD
MARSH
PHASE IV
FGD BYPRODUCT STORAGE/DISPOSAL AREA
DREDGE DISPOSAL AREA
S 4000
N 1 251 056.74

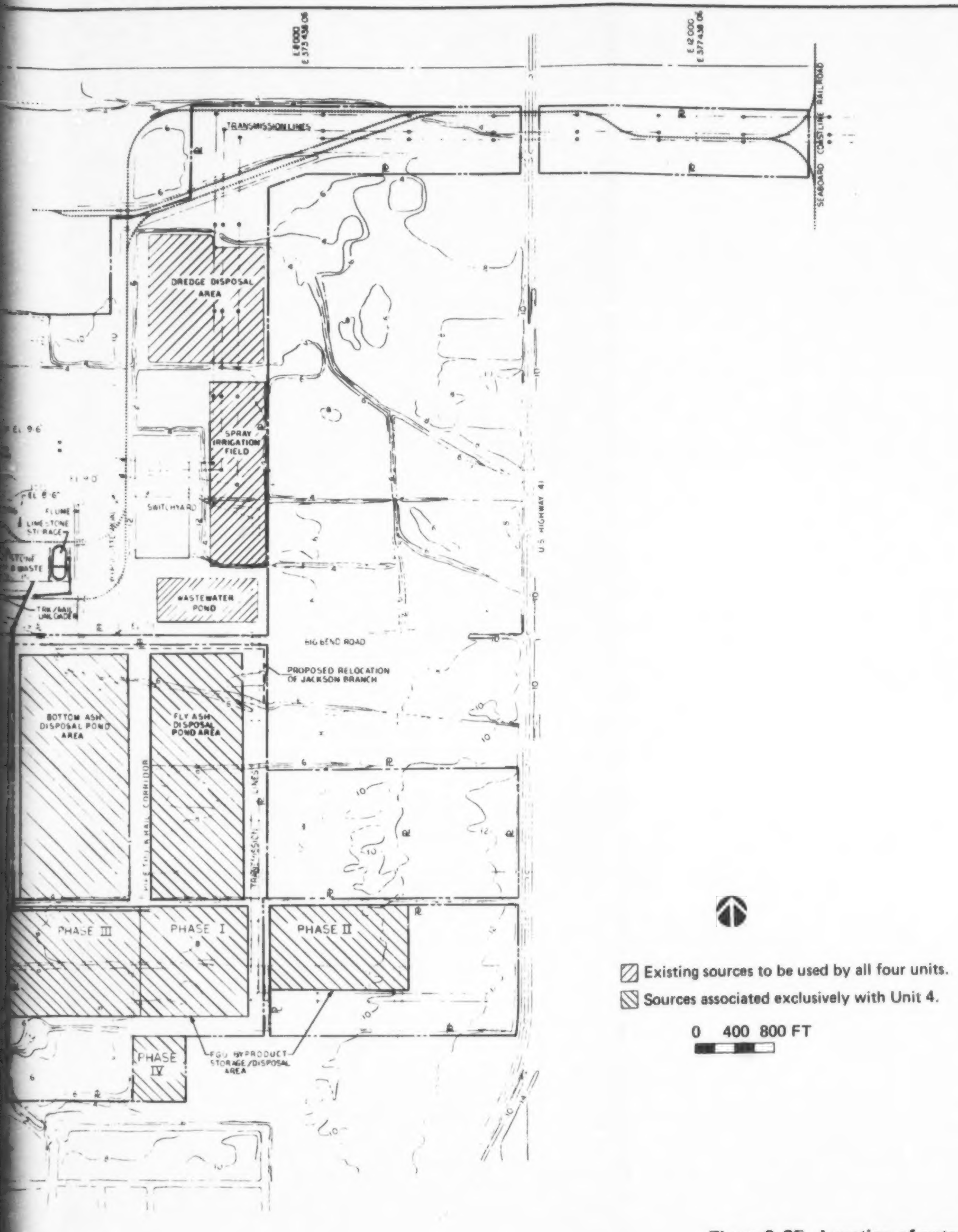

E 8000
E 373 438 06
E 12 000
E 377 438 06
TRANSMISSION LINES
SEABOARD COASTLINE RAILROAD
DREDGE DISPOSAL AREA
SPRAY IRRIGATION FIELD
SWITCHYARD
EL 9.6'
EL 9.0
EL 8.6'
FLUME
LIMESTONE STORAGE
STONE & WASTE
TRK/RAIL UNLOADER
WASTEWATER POND
U.S. HIGHWAY 41
BIG BEND ROAD
PROPOSED RELOCATION OF JACKSON BRANCH
BOTTOM ASH DISPOSAL POND AREA
FLY ASH DISPOSAL POND AREA
PIPE/TRUCK RAIL CORRIDOR
TRANSMISSION LINES
PHASE III
PHASE I
PHASE II
PHASE IV
FGD BYPRODUCT STORAGE/DISPOSAL AREA
▨ Existing sources to be used by all four units.
▧ Sources associated exclusively with Unit 4.
0 400 800 FT

Figure 6-35. Location of potential sources of ground-water impact, Big Bend Station.

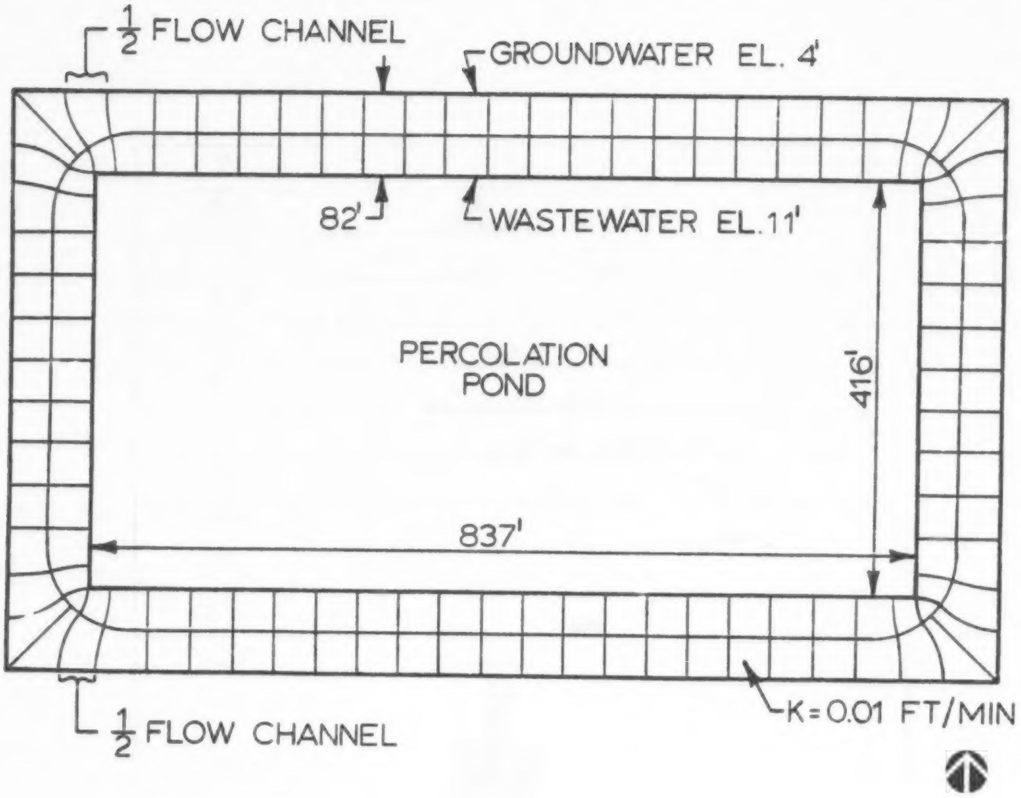
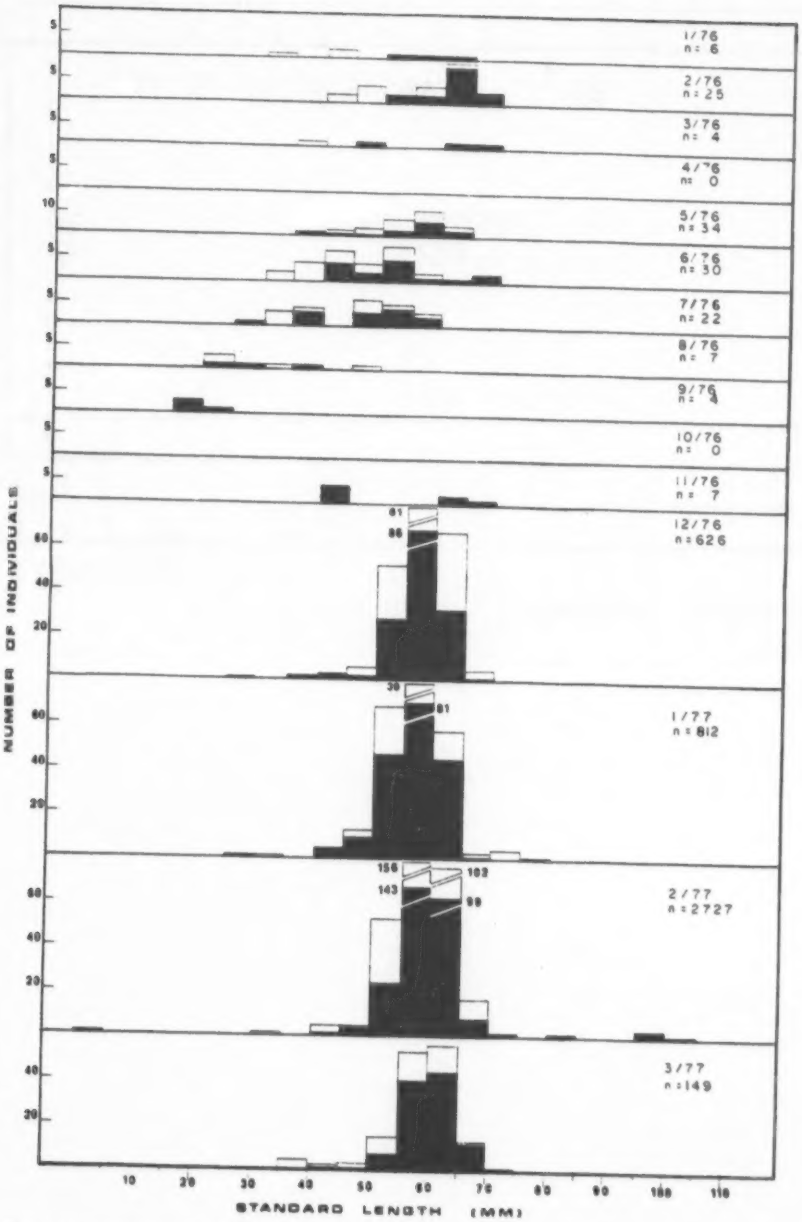
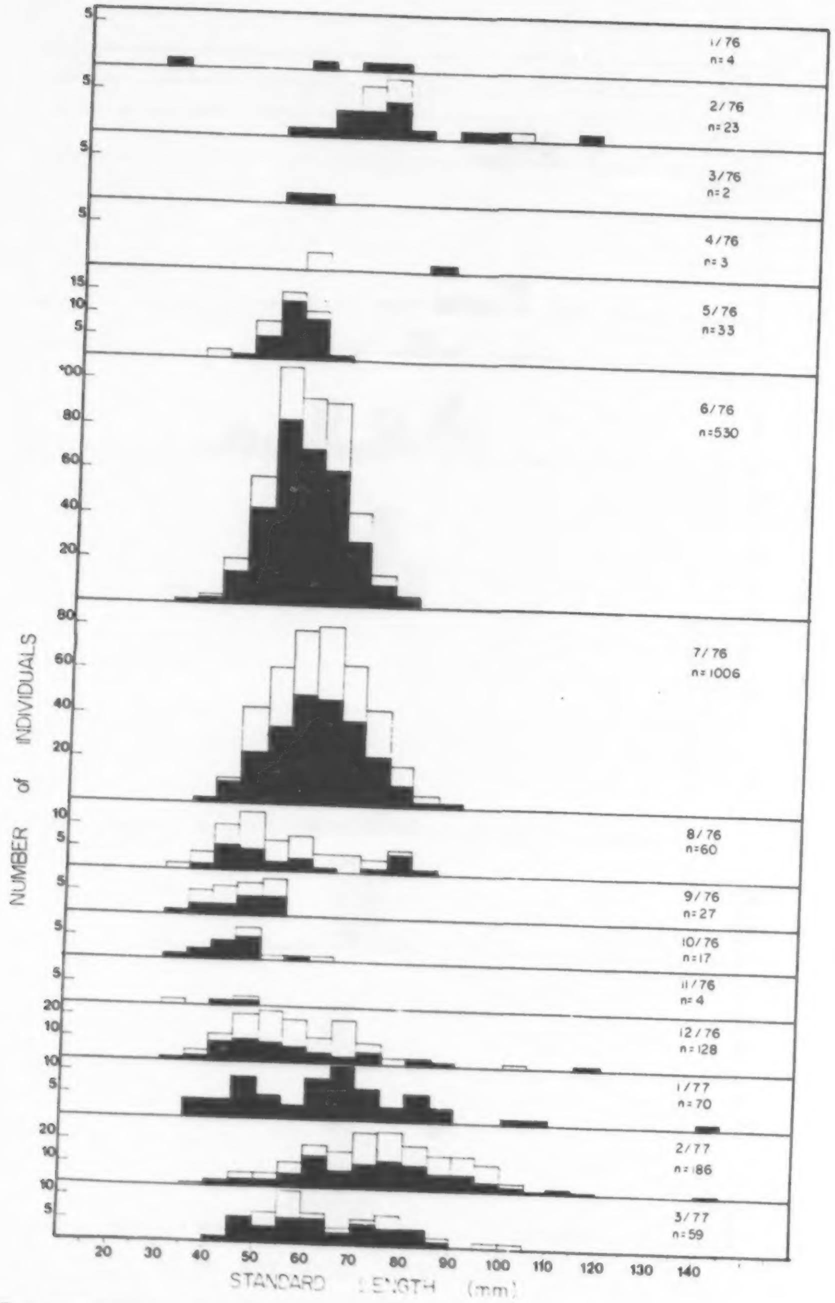

½ FLOW CHANNEL
GROUNDWATER EL. 4'
82'
WASTEWATER EL.11'
PERCOLATION POND
416'
837'
½ FLOW CHANNEL
K=0.01 FT/MIN

Figure 6-36. Flow net of the wastewater pond, Big Bend Station.



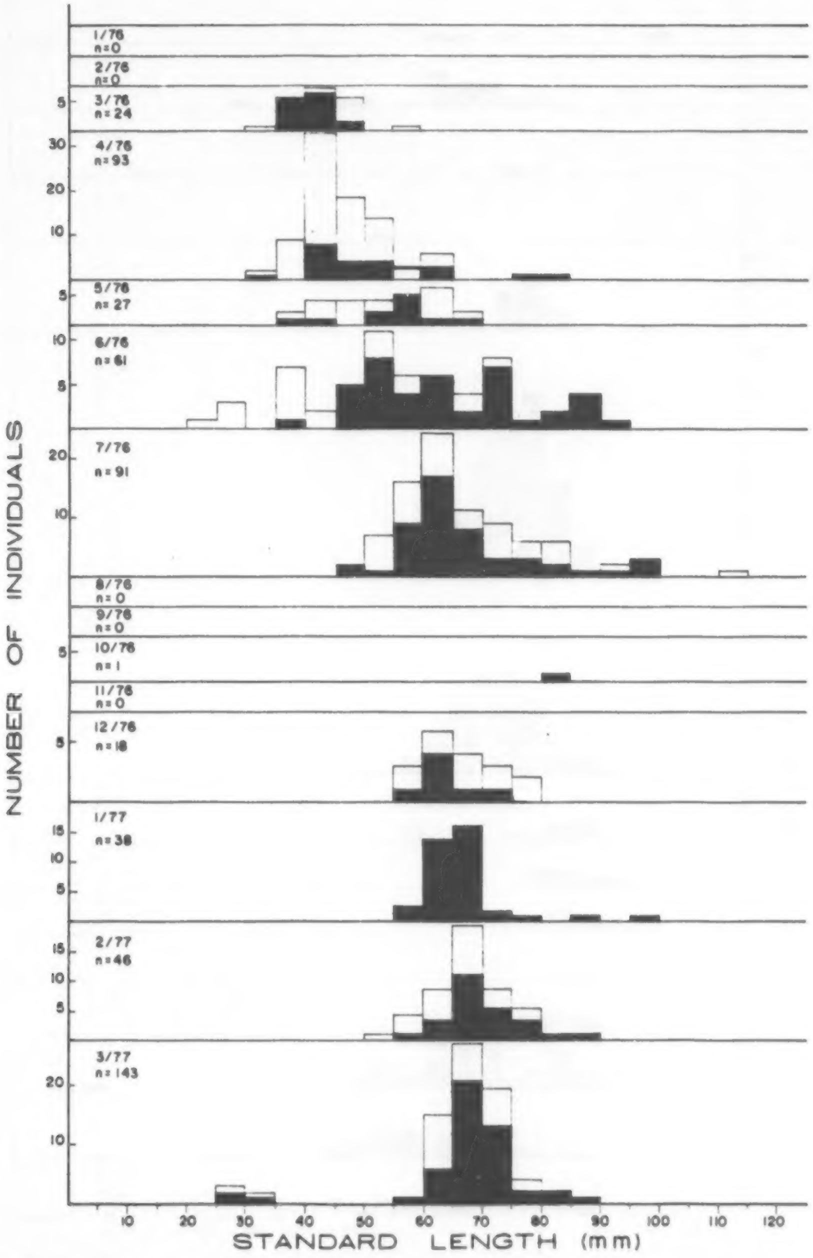
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-37. Standard length distribution of *Anchoa mitchilli* (bay anchovy) from January 1976 through March 1977.



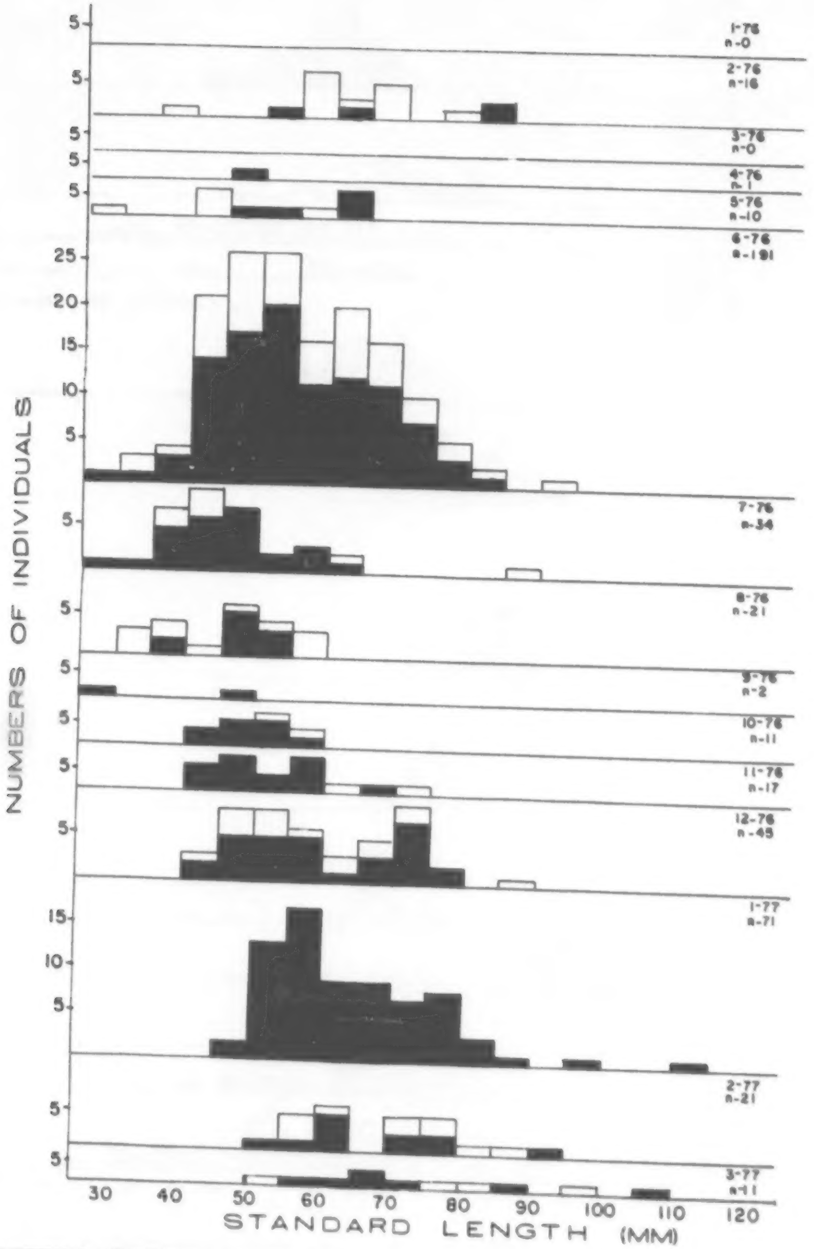
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-38. Standard length distribution of *Bairdiella chrysoura* (silver perch) from January 1976 through March 1977.



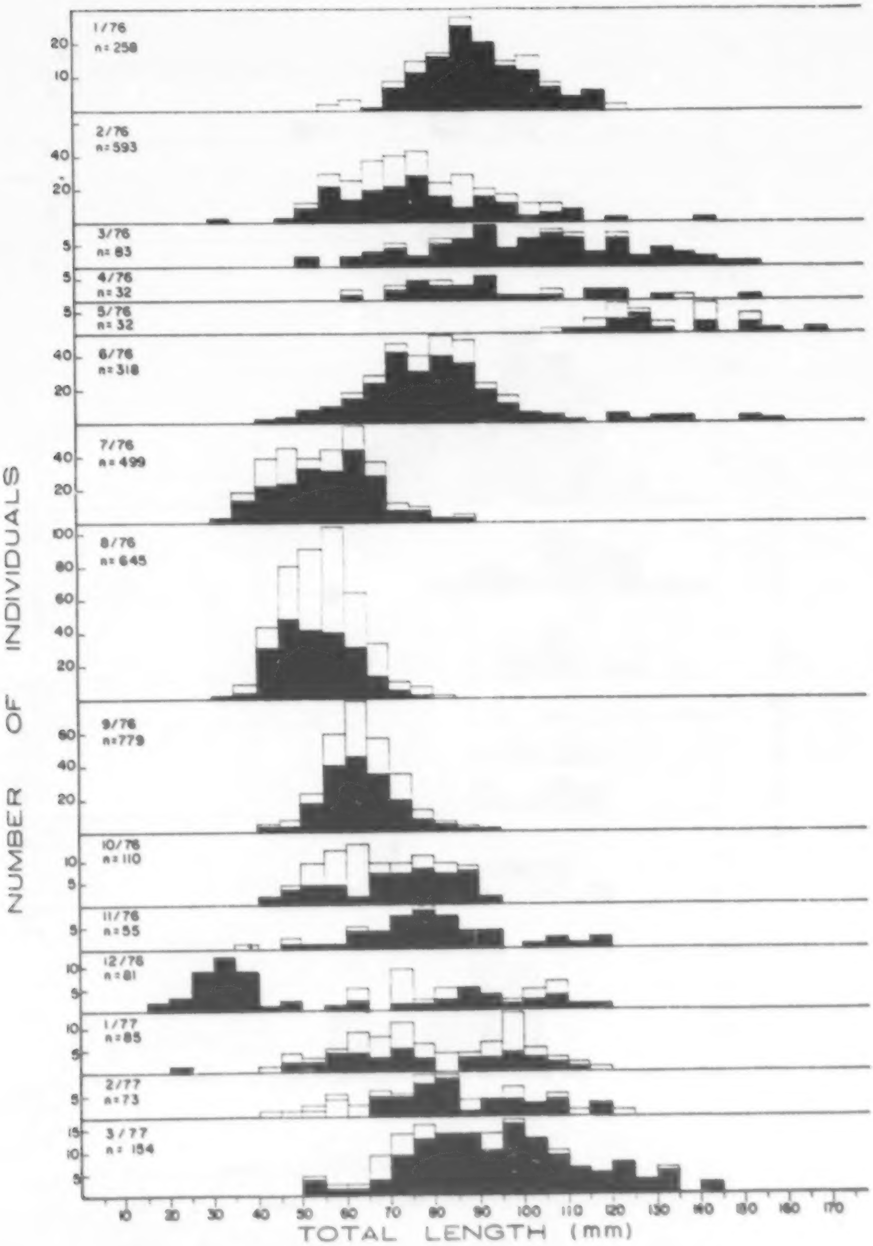
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-39. Standard length distribution of *Lagodon rhomboides* (pinfish) from January 1976 through March 1977.



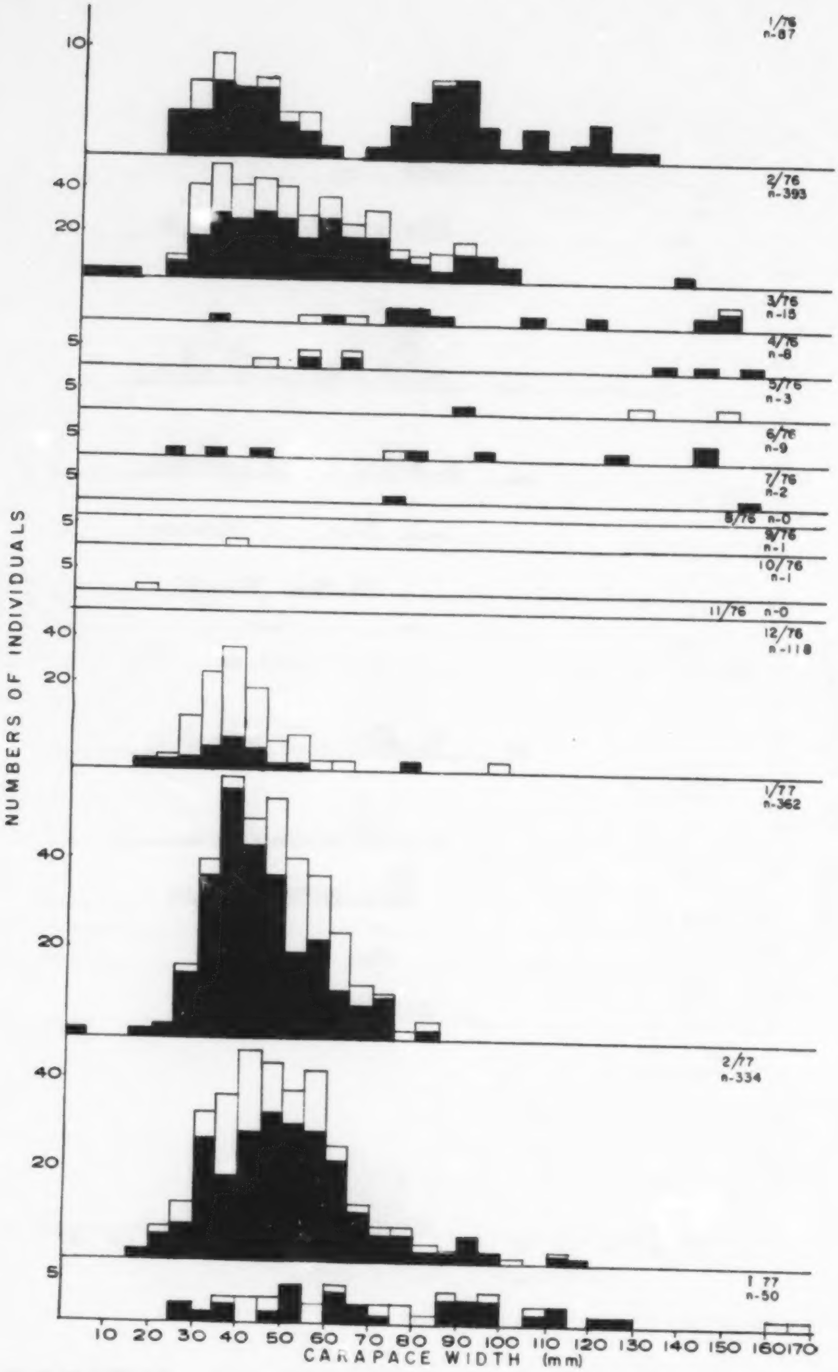
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-40. Standard length distribution of *Cynoscion arenarius* (sand seatrout) from January 1976 through March 1977.



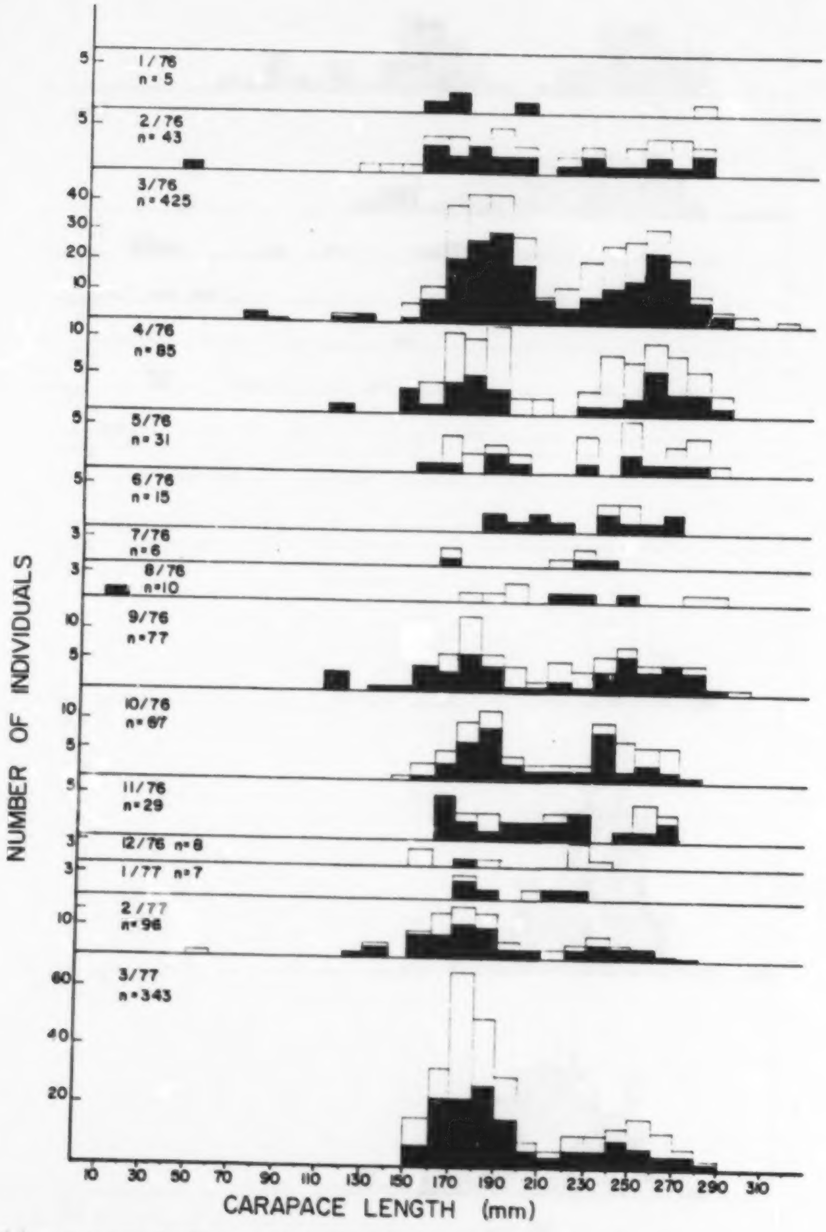
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-41. Length distribution of *Penaeus duorarum* (pink shrimp) from January 1976 through March 1977.



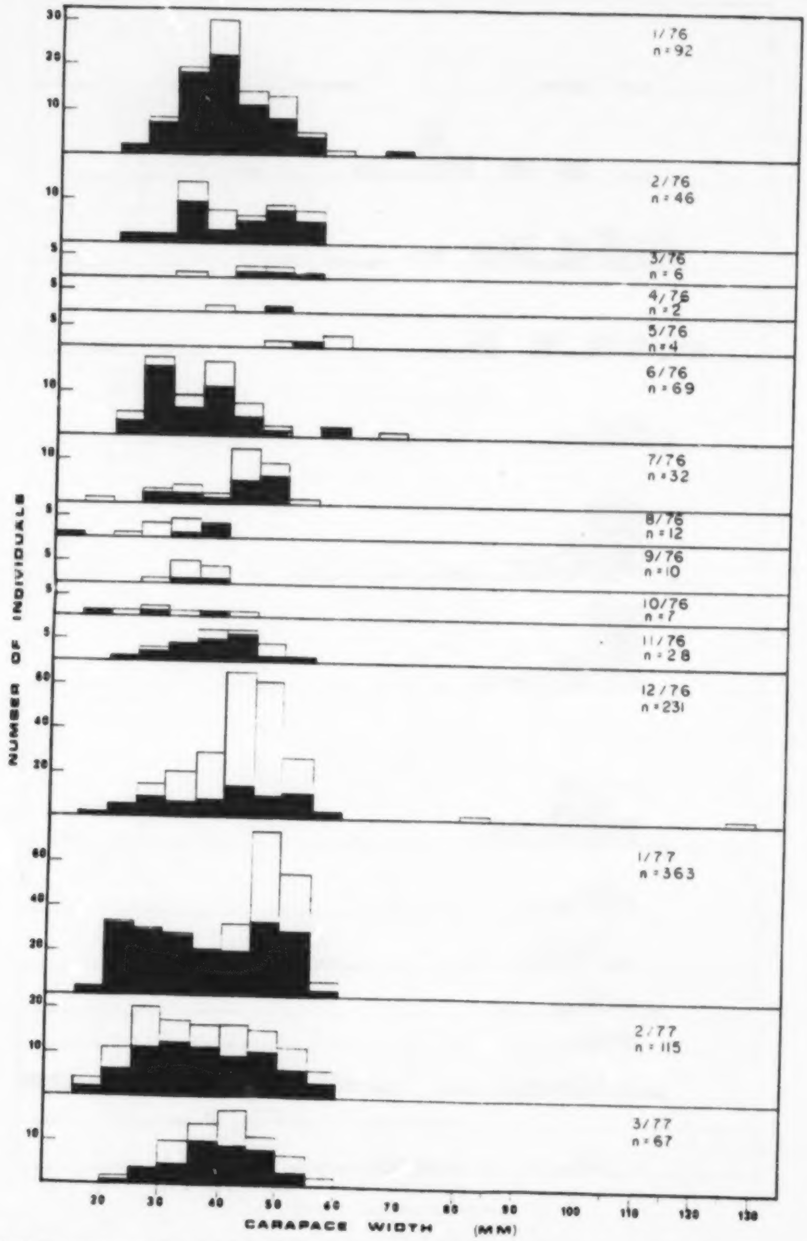
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-42. Standard length distribution of *Callinectes sapidus* (blue crab) from January 1976 through March 1977.



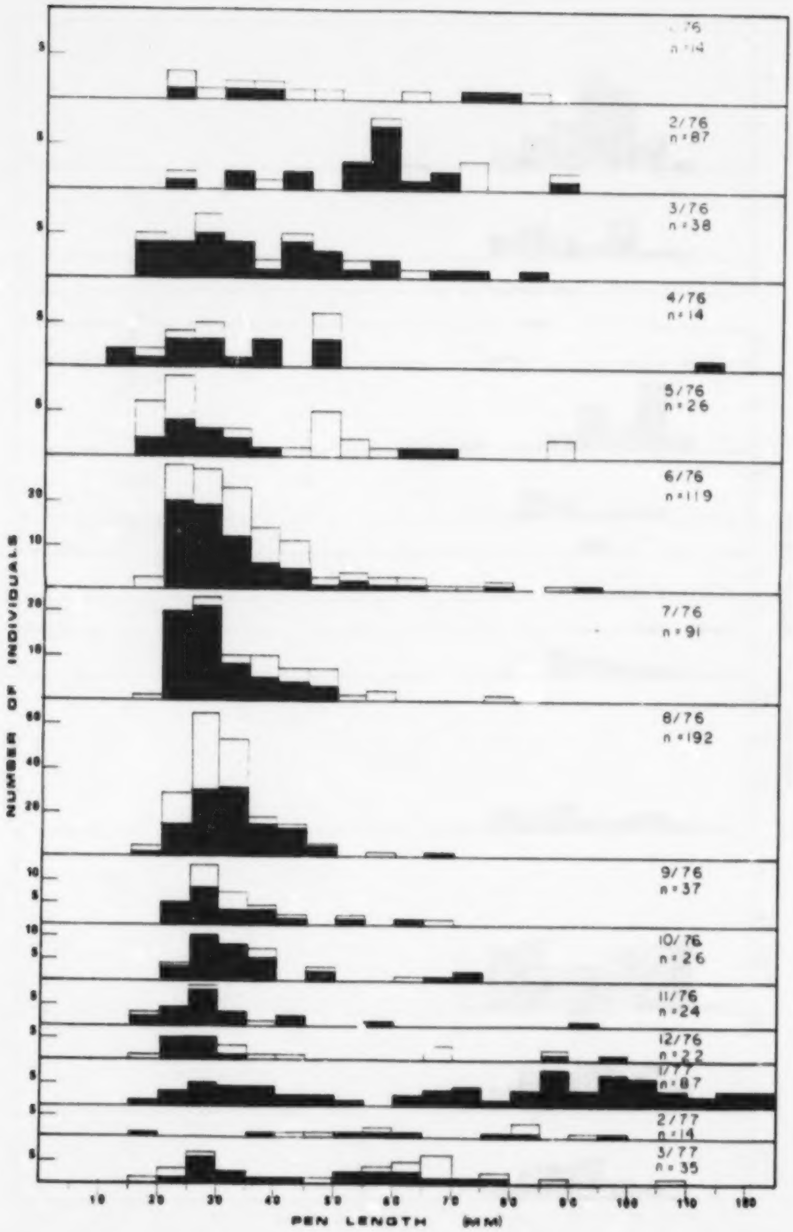
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-43. Standard length distribution of *Limulus polyphemus* (horseshoe crab) from January 1976 through March 1977.



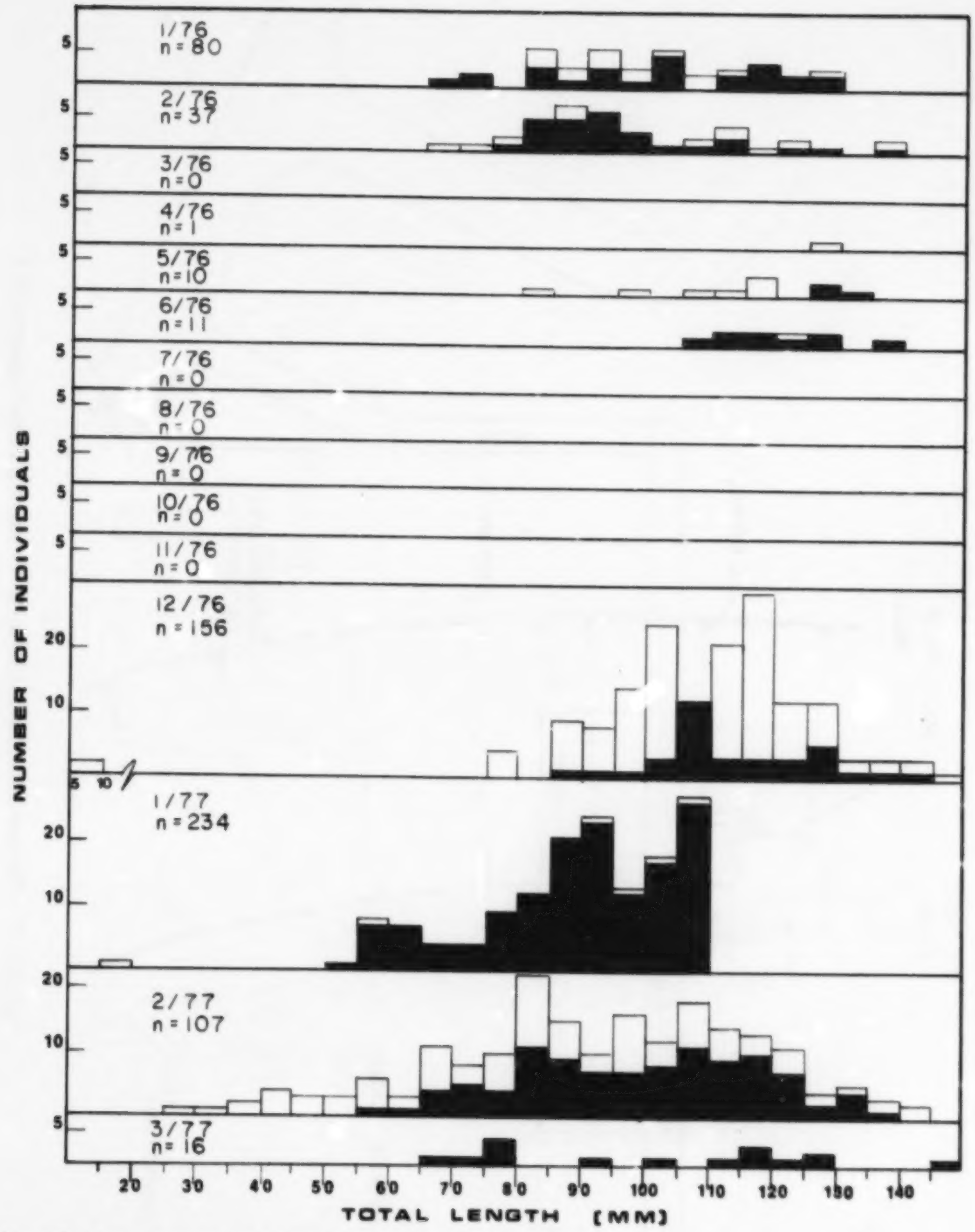
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-44. Standard length distribution of *Portunus gibbesi* (Portunid crab) from January 1976 through March 1977.



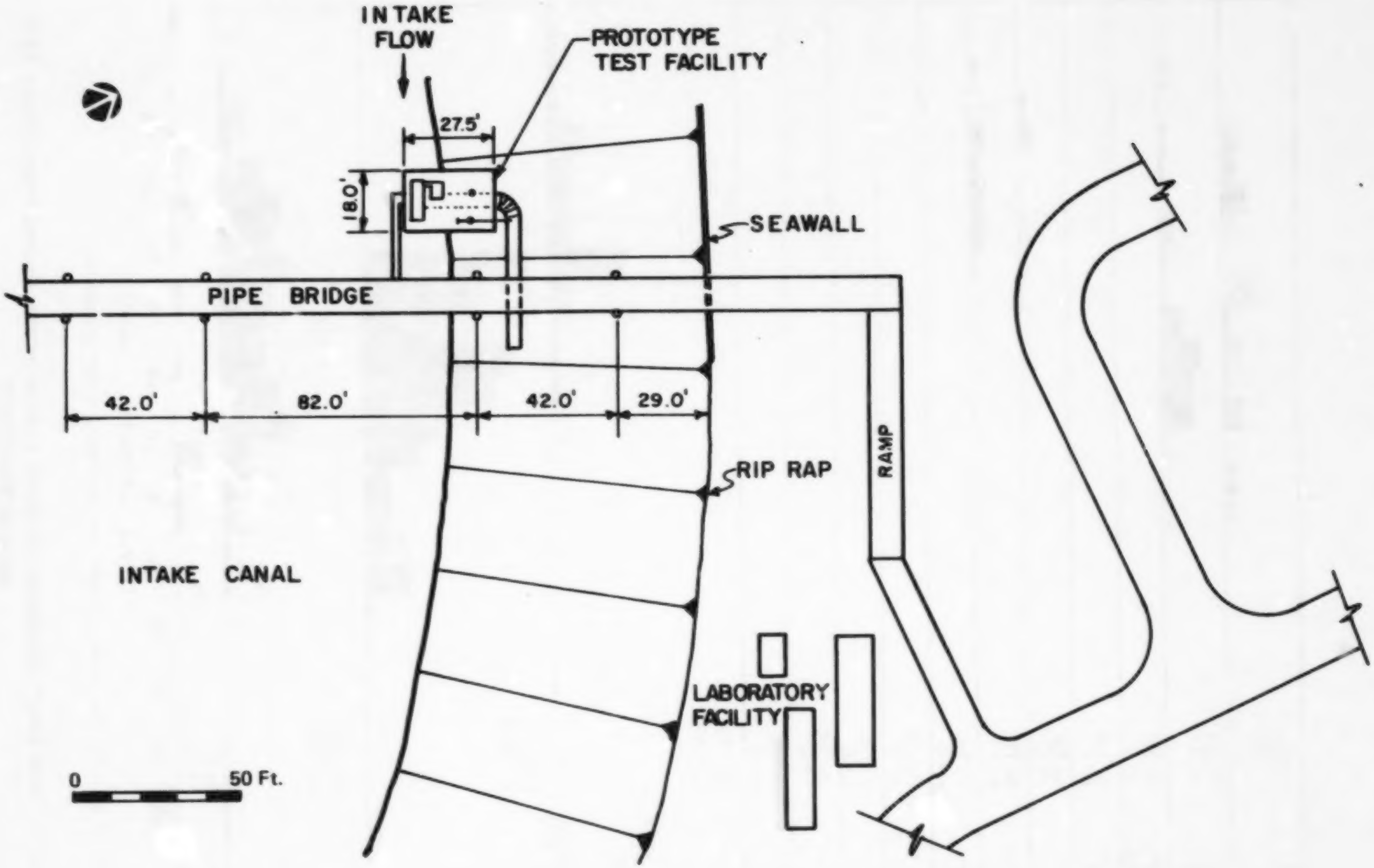
Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-45. Pen length distribution of *Lolliguncula brevis* (brief squid) from January 1976 through March 1977.



Note: Each bar represents a 5-millimeter-size class. Dark areas represent night impingement.

Figure 6-46. Total length distribution of *Squilla empusa* (mantis shrimp) from January 1976 through March 1977.



INTAKE FLOW
PROTOTYPE TEST FACILITY
27.5'
18.0'
SEAWALL
PIPE BRIDGE
42.0'
82.0'
42.0'
29.0'
RIP RAP
RAMP
INTAKE CANAL
LABORATORY FACILITY
0
50 Ft.

Figure 6-47. Site plan, prototype fine-mesh screen, Big Bend Station Unit 4.

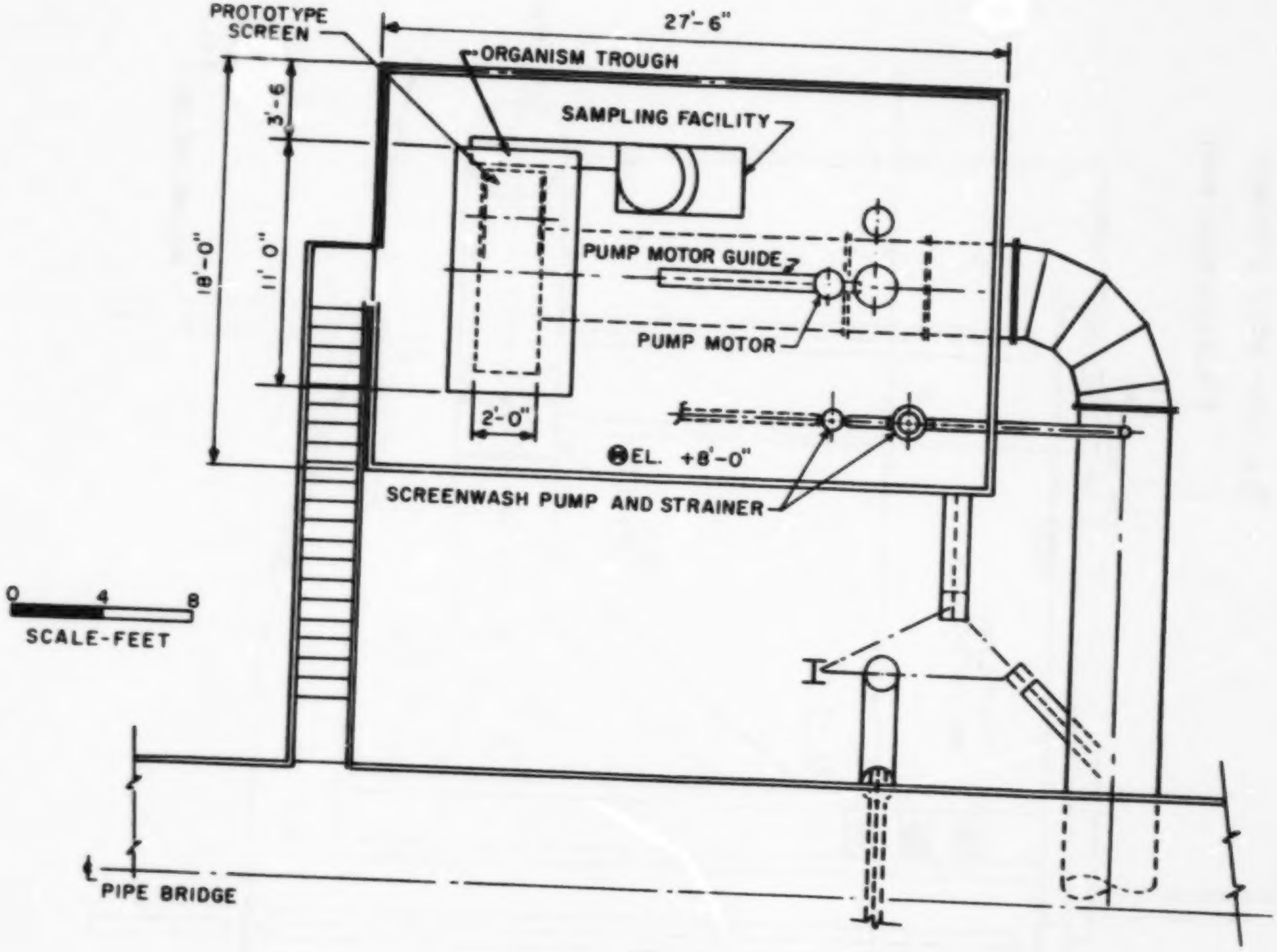

PROTOTYPE SCREEN
27'-6"
ORGANISM TROUGH
SAMPLING FACILITY
3'-6
18'-0"
11' 0"
PUMP MOTOR GUIDE
PUMP MOTOR
2'-0"
EL. +8'-0"
SCREENWASH PUMP AND STRAINER
0
4
8
SCALE-FEET
PIPE BRIDGE

Figure 6-48. Deck arrangement, prototype fine-mesh screen, Big Bend Station Unit 4.

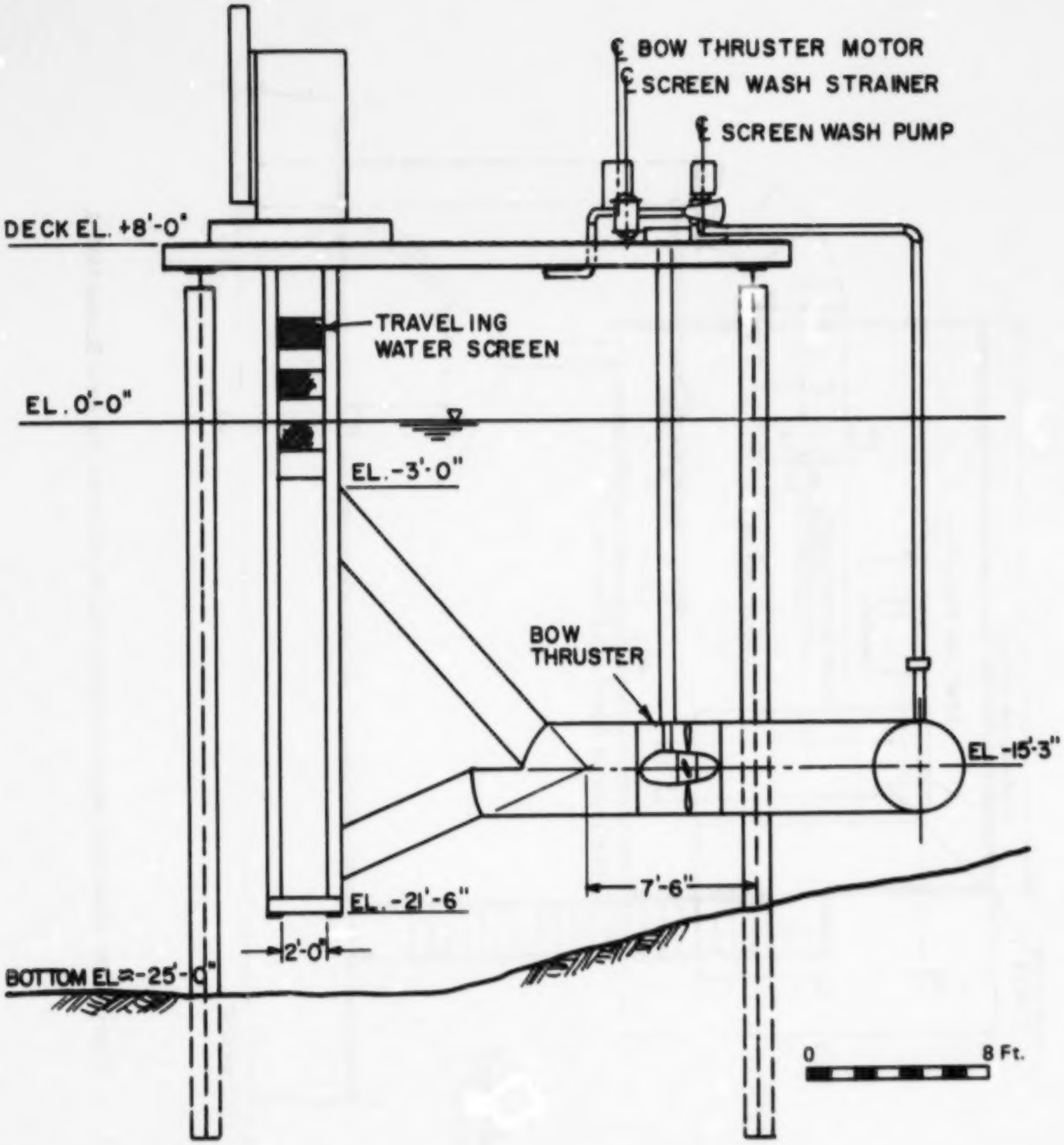

℄ BOW THRUSTER MOTOR
℄ SCREEN WASH STRAINER
℄ SCREEN WASH PUMP
DECK EL. +8'-0"
TRAVELING WATER SCREEN
EL. 0'-0"
EL. -3'-0"
BOW THRUSTER
EL -15'-3"
7'-6"
EL. -21'-6"
2'-0"
BOTTOM EL≈-25'-0"
0
8 Ft.

Figure 6-49. Profile arrangement, prototype fine-mesh screen, Big Bend Station Unit 4.

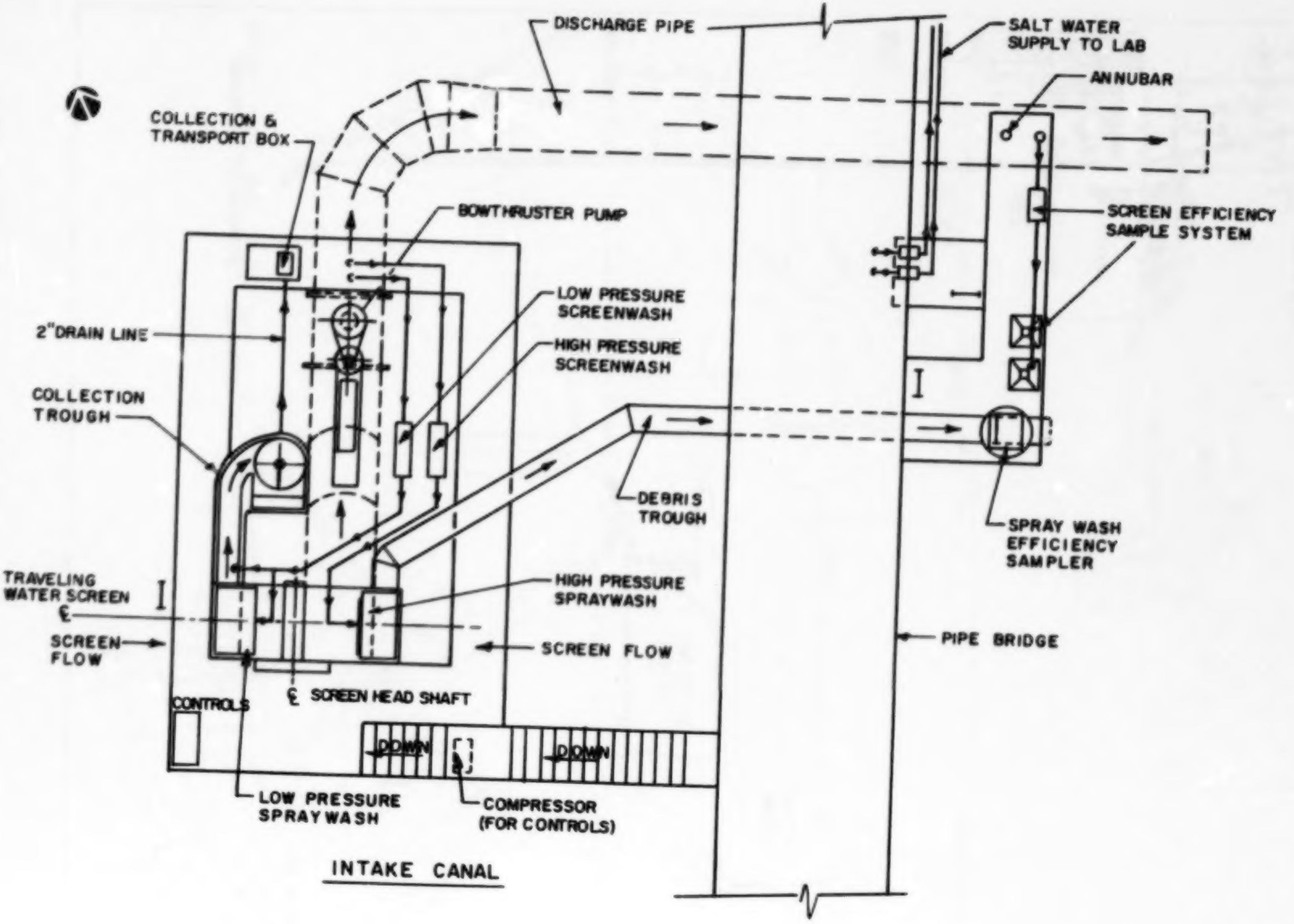

DISCHARGE PIPE
SALT WATER SUPPLY TO LAB
ANNUBAR
COLLECTION & TRANSPORT BOX
BOWTHRUSTER PUMP
SCREEN EFFICIENCY SAMPLE SYSTEM
LOW PRESSURE SCREENWASH
2"DRAIN LINE
HIGH PRESSURE SCREENWASH
COLLECTION TROUGH
DEBRIS TROUGH
SPRAY WASH EFFICIENCY SAMPLER
TRAVELING WATER SCREEN ℄
HIGH PRESSURE SPRAYWASH
SCREEN FLOW
SCREEN FLOW
PIPE BRIDGE
CONTROLS
℄ SCREEN HEAD SHAFT
DOWN
DOWN
LOW PRESSURE SPRAYWASH
COMPRESSOR (FOR CONTROLS)
INTAKE CANAL

Figure 6-50. Deck arrangement for fine-mesh screen test facility, prototype fine-mesh screen, Big Bend Station Unit 4.

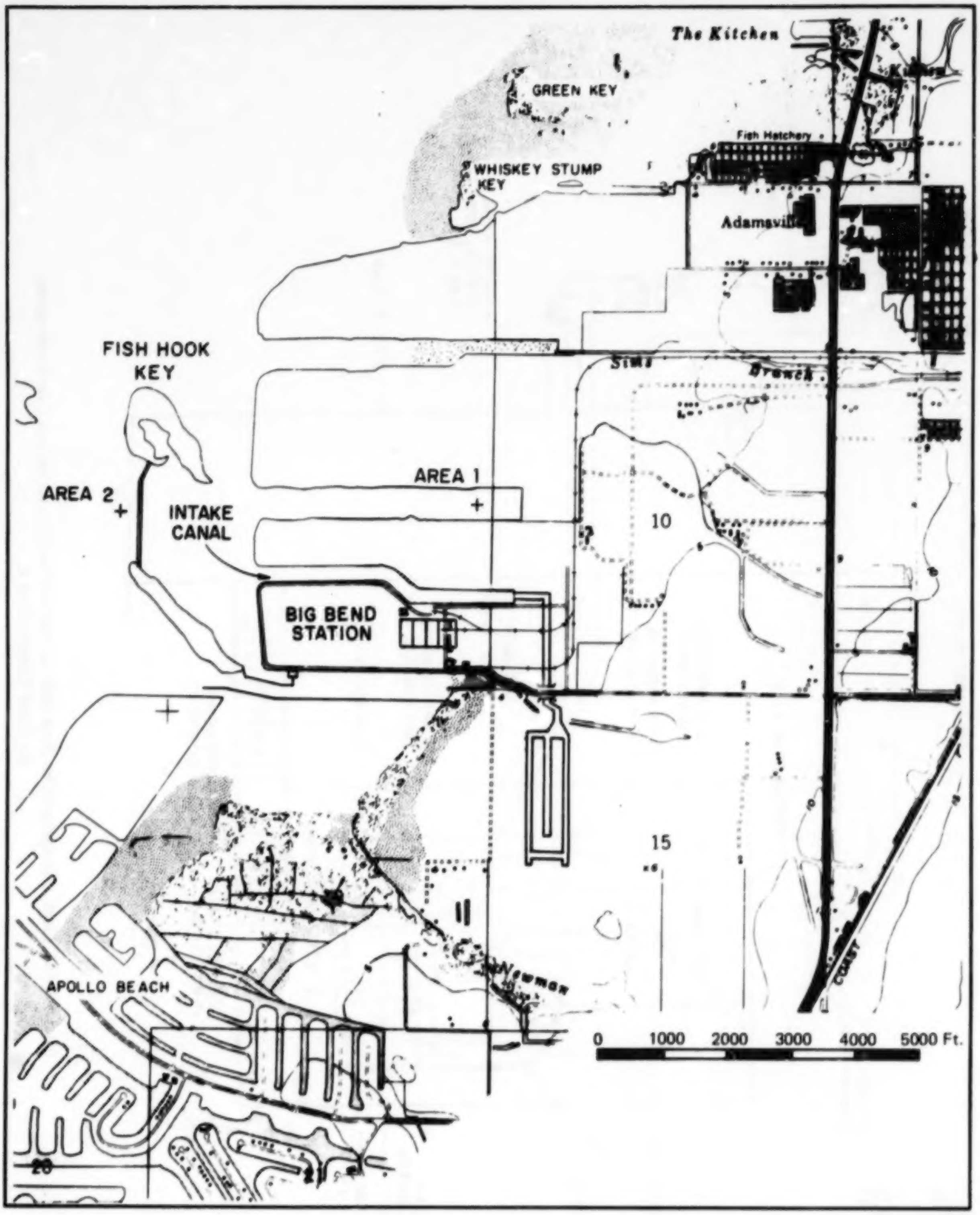

The Kitchen
GREEN KEY
Fish Hatchery
WHISKEY STUMP KEY
Adamsville
FISH HOOK KEY
Sims Branch
AREA 1
AREA 2
INTAKE CANAL
10
BIG BEND STATION
15
11
Newman
APOLLO BEACH
COAST
0
1000
2000
3000
4000
5000 Ft.
20

Figure 6-51. Alternative release locations, prototype fine-mesh screen, Big Bend Station Unit 4.

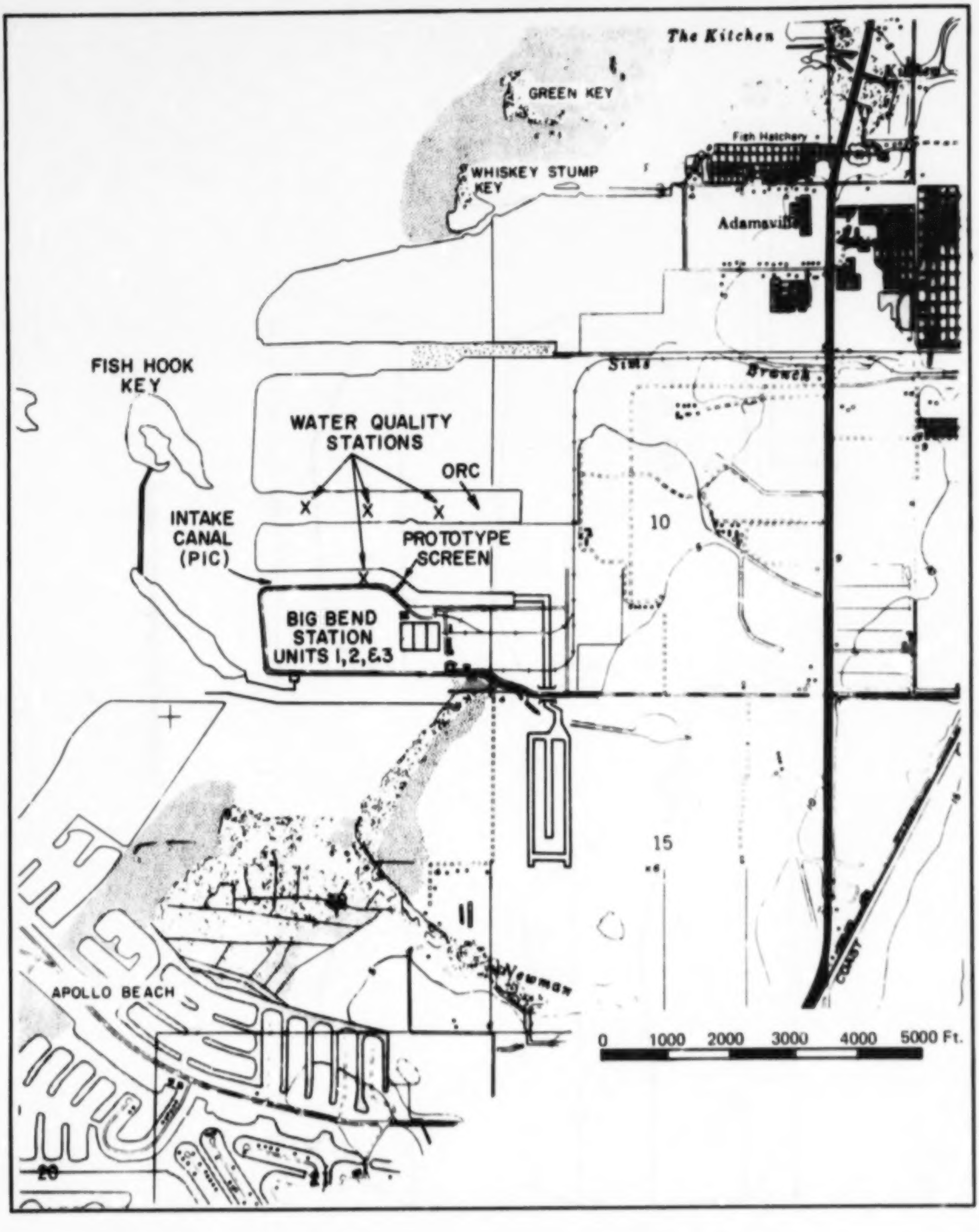

The Kitchen
GREEN KEY
Fish Hatchery
WHISKEY STUMP KEY
Adamsville
Sims Branch
FISH HOOK KEY
WATER QUALITY STATIONS
ORC
X
X
X
INTAKE CANAL (PIC)
PROTOTYPE SCREEN
BIG BEND STATION UNITS 1,2,&3
10
15
11
Newman
APOLLO BEACH
COAST
20
0
1000
2000
3000
4000
5000 Ft.

Figure 6-52. Biological and water-quality sampling stations, prototype fine-mesh screen, Big Bend Station Unit 4.

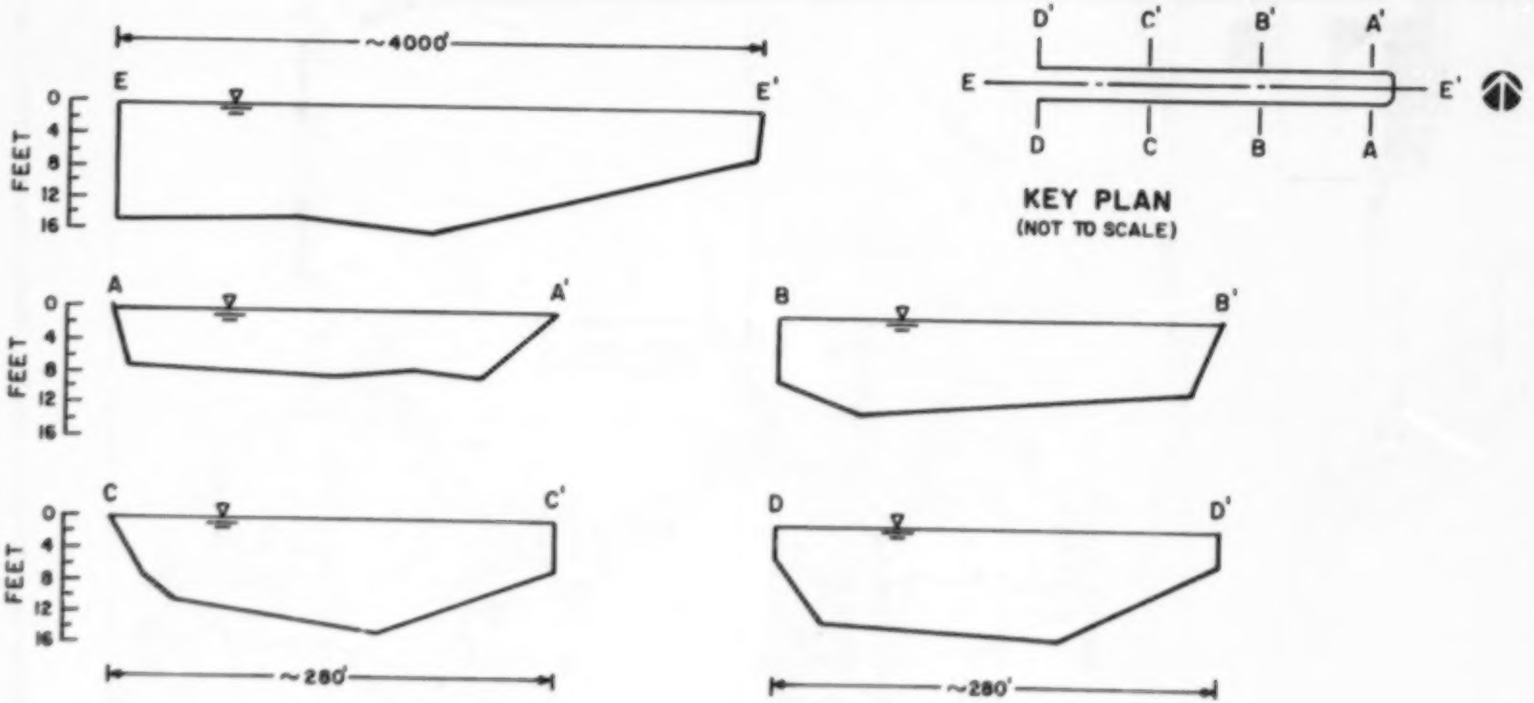

~4000'
E
E'
FEET
0
4
8
12
16
A
A'
B
B'
C
C'
D
D'
~280'
~280'
KEY PLAN
(NOT TO SCALE)

Figure 6-53. Dimensions of organism return canal.

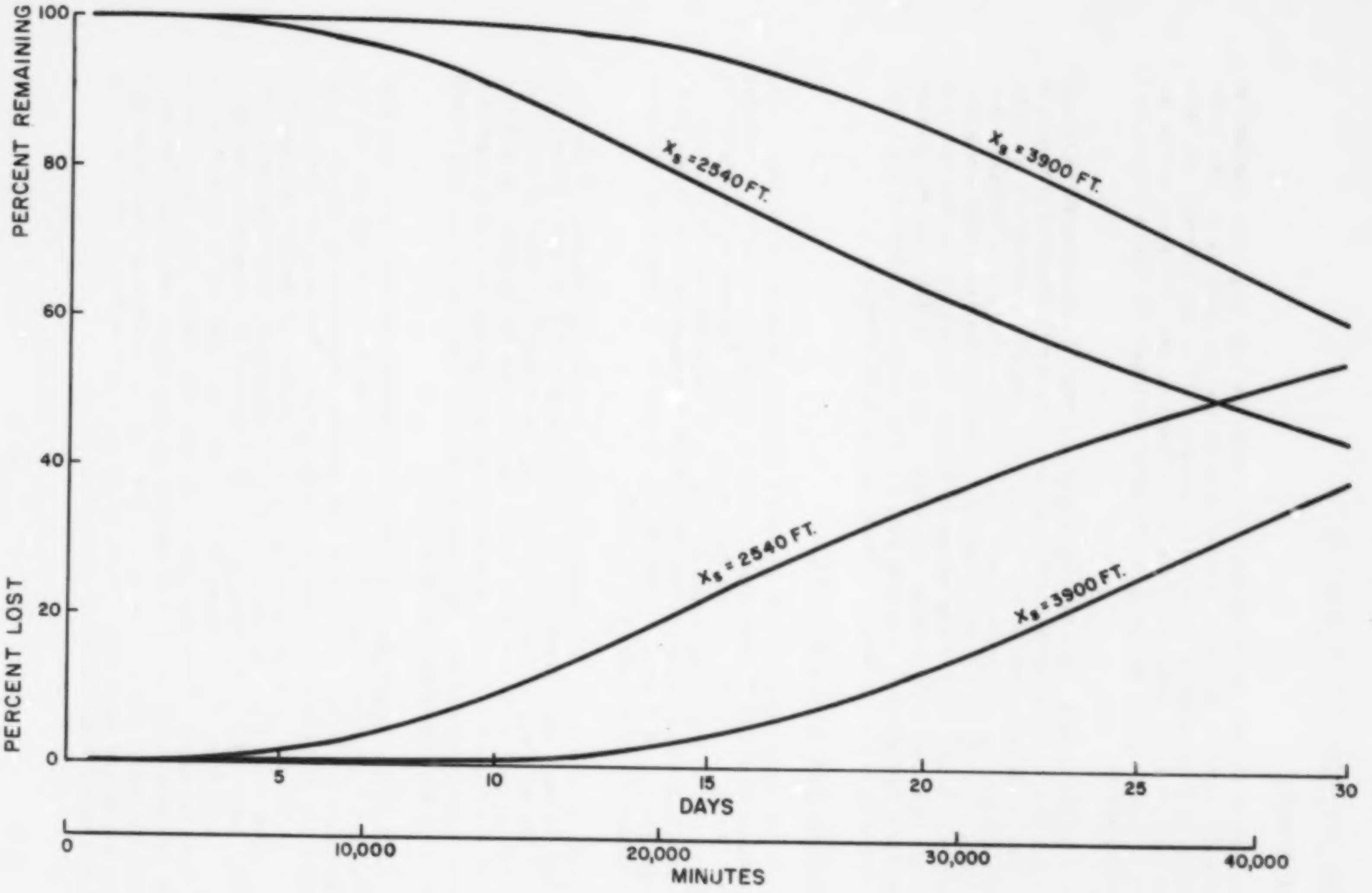


Figure 6-54. Disposal of organisms after batch release at two locations in the organism return canal, Big Bend Station.

6.4 SECONDARY OPERATIONS IMPACTS

6.4.1 ATMOSPHERE

Possible secondary effects of powerplant emissions include long-term (decade or more) worldwide climatic changes. Carbon dioxide and particulates are the emissions of major concern relative to climatic changes. However, although Big Bend Unit 4 will contribute to such emissions, the effects of any individual source are regarded as inconsequential compared to the total worldwide emissions summarized in Tables 6-68 and 6-69.

The proposed Big Bend Unit 4 will be a significant emitter of sulfur dioxide (SO_2) and nitrogen oxides (NO_x). These air pollutants will be converted by chemical processes in the atmosphere to sulfates and ozone (O_3). Sulfur dioxide is converted to sulfur trioxide (SO_3), which is a precursor of sulfates (SO_4) and sulfuric acid (H_2SO_4). Sulfuric acid may contribute to acid rain; however, no quantitative cause-effect relationship between SO_2 emissions and the measured acidity of precipitation has yet been determined between individual sources and receptor areas. Sulfates are the primary cause of visibility degradation. The following is a qualitative discussion of the transformation mechanisms and the impact of these secondary pollutants.

6.4.1.1 Sulfates, Acid Rain, and Visibility

Sulfur compounds, once emitted, are ultimately removed from the atmosphere, primarily by precipitation and dry deposition. Most of the SO_2 is converted to sulfates (SO_4) either before or during the removal process (U.S. Environmental Protection Agency [EPA] 1971). Scavenging rates for SO_2 and sulfates are not well quantified, but global mass balance estimates of the atmospheric residence times for sulfur compounds range from 1 to 8 days, suggesting the possibility of long-range transport (Robinson and Robbins 1968; Kellogg et al. 1975).

The mechanisms by which SO_2 is oxidized to sulfates are not well understood, but they are important because they determine the formation rate and, to some extent, the final form of the sulfates. Atmospheric SO_2 may be oxidized to SO_3 and converted to sulfuric acid aerosol, or it may form sulfite ions that are then oxidized to sulfates. Subsequent to the oxidation, sulfuric acid or sulfates may interact with other materials to form other sulfate compounds. The most important sulfate formation mechanisms identified to date are summarized in Table 6-70.

The rates of oxidation associated with these mechanisms can vary with humidity, temperature, and concentrations of the reactants (Brosset 1973). At ambient concentrations, Mechanism 1 (Table 6-70) is slow and probably important only for very long-range transport of low pollutant levels on a global scale. The rates for Mechanisms 2 through 5 are thought to range between 1 and 20 percent of the SO_2 oxidized per hour, which could make them significant in urban or other areas near important emission sources. Sulfate formation rates are usually enhanced by increases in humidity. Preliminary results from recent studies indicate that, for distances of up to 30 miles downwind from the source, powerplant plume SO_2 oxidation rates were 1 to 2 percent per hour for coal combustion and 10 to 20 percent per hour for oil combustion (Newman, Forrest, and Manowitz 1974). The more rapid rate in oil-fired plumes is thought to be due to the lack of particulate control, which permits vanadium or other catalytic particulates to accelerate oxidation in the plume.

Current EPA studies suggest that SO_2 oxidation rates in coal-fired powerplant plumes are initially inhibited by high concentrations of nitric oxide (NO), with conversion rates increasing several miles downwind as the plume encounters ambient oxidants and perhaps ammonia from rural background or urban plumes. Observation of conditions favorable to photochemical oxidant formation in a powerplant plume 25 miles downwind of the source supports this conclusion (Newman, Forrest, and Manowitz 1974). Near the source, NO levels were found to be sufficient to depress preexisting oxidant concentrations, whereas farther downwind, the NO was depleted and increases in oxidant levels were observed. A consideration of possible reaction mechanisms suggests that SO_2 conversion will be slow during the early stages of plume dispersion, but that it will increase as more ambient air mixes with the plume. Background oxidants that are entrained into the plume will preferentially oxidize NO to nitrogen dioxide (NO_2). However, after some NO is converted to NO_2, nitrous acid (HNO_2) can form and be dissociated by sunlight to yield OH, which proceeds to oxidize SO_2 by Mechanism 2. Entrained oxidants can react directly with SO_2 dissolved in liquid droplets or wet aerosol particles after NO is converted to NO_2. The amount of SO_2 dissolving in the liquid (droplet or film) is governed by the pH of the solution. As the liquid becomes acidic, SO_2 dissolution is inhibited. Ammonia, present in the ambient air, probably controls this process (Mechanism 3). Thus, the EPA observation of a slow initial conversion rate in plumes, increasing as the plume disperses, is mechanistically reasonable.

The extent of oxidation for Mechanisms 2 through 5 may be more dependent on concentrations of precursors other than SO_2. Therefore, a reduction in ambient SO_2 concentration may not produce a corresponding decrease in sulfate production if these precursors are limiting factors. The actual oxidation rates and controlling mechanisms under realistic environmental conditions are poorly understood, thus precluding a quantitative assessment of the role of such precursors.

Some confusion has existed regarding the relative removal of SO_2 and sulfate aerosols by ground and other dry surface deposition. The deposition velocity of aerosols depends on the particle size, and this velocity is negligible at the accumulation mode size range for sulfates of between 0.1 and 1.0 micrometer. Although SO_2 is removed fairly rapidly by dry deposition on soil, vegetation, and other surfaces, once the SO_2 has been converted to sulfates the removal processes become very slow. Sulfates, or any secondary accumulation mode aerosol (fine particulate matter) can, therefore, travel long distances before removal by fallout or rainout.

The wet removal of SO_2 from the atmosphere, a prime mechanism of acid rain formation, is accomplished by the capture of sulfate particles formed by the oxidation of SO_2 in the cloud. There are two capture processes: rainout and washout. The capture of sulfate particles by the cloud droplets is called rainout. The capture of gas and sulfate particles by falling raindrops is known as washout. The rainout period is much longer than the washout period. Based on experimental findings, Miller and DePena (1972) concluded that the sulfate content of rainwater results from particle washout rather than gaseous washout.

Almost no data have been collected to evaluate the pH of rainfall in Florida. Studies offer only preliminary findings. Brezonik et al. (1980) notes a general increase in rainfall pH from north to south in the state. In north-central Florida, the weighted mean pH was about 5.0. It also appears that inland stations exhibited lower pH in rainfall than coastal stations. Rainfall in equilibrium with atmospheric concentrations of carbon dioxide will have a pH of 5.5 to 5.6.

Sulfate aerosols are formed by a gas-to-particle conversion that occurs in the accumulation mode. Particles in this size range (0.1 to 1.0 micrometer) have very long lifetimes; the only efficient removal mechanisms are the cloud formation processes of rainout and washout. These particles are most effective in scattering light and therefore influence visibility. Sulfate aerosols can absorb water and increase in size; sulfuric acid and ammonium bisulfate (NH_4HSO_4) do so at all humidities, and ammonium sulfate $[(NH_4)_2SO_4]$ does so at relative humidities above about 65 percent (Charlson et al. 1974). As a result, the visibility reduction caused by aerosols can be much greater than might be expected on a mass basis.

There seems to be a correlation between the concentration of aerosols and visibility degradation for the particle size range 0.1 to 1.0 micrometer. It turns out that sulfates roughly account for about 50 percent of the aerosol mass in this size range. Experiments in Florida have yielded similar results (Hardy et al. 1976). The conversion (oxidation, etc.) rate of SO_2 to sulfates is about 1 to 20 percent per hour, and the dry deposition rate approximates that figure; hence, there is ample time for conversion of SO_2 to sulfates within the Tampa area. Evaluation of the increased effects of SO_2 relative to visibility degradation via sulfate formation is not straightforward. Temperature, solar radiation, and relative humidity have a significant effect on these correlations. Maritime climate has unique aerosol formation characteristics, and high relative humidity has quite a significant effect on aerosol growth.

The phenomena of sulfate formation, acid rain, and visibility degradation cannot be adequately modeled with available technology. However, Big Bend Unit 4 SO_2 emissions are limited by new source performance standards (NSPS), and thus the concentrations of this necessary precursor of acid rain and sulfates, which may cause visibility degradation, are not expected to be significant.

6.4.1.2 Ozone

Nitrogen dioxide is one of the primary precursors of the formation of photochemical oxidants primarily measured as O_3. Ozone and other oxidants from anthropogenic sources are products of atmospheric photochemical reactions involving primarily organic and inorganic pollutants and atmospheric oxygen. More specifically, the oxidant formation process is initiated by the photolysis of light-absorbing air contaminants such as NO_2, aldehydes, and O_3, resulting in the formation of highly reactive radicals that subsequently react with organic pollutants. The net result of this photochemical activity is the accumulation of O_3 and other oxidants. The concentrations depend on meteorological conditions such as sunlight intensity, air stagnation, and temperature and on primary pollutant precursor concentrations, composition, and distribution. In fact, the variety of factors predisposing to oxidant formation makes the determination of pollutant impact very complex.

The overall chemical changes that occur when a mixture of HC and NO_x pollutants is exposed to sunlight under conditions similar to those in the atmosphere are illustrated in Figure 6-55 (U.S. Environmental Protection Agency 1978). The curves in the figure show the overall photochemical process as consisting of two distinct reaction stages occurring consecutively. During the first stage, NO is converted into NO_2 without any appreciable buildup of O_3 or other non-NO_2 oxidants. The second stage, which starts when almost all of the NO has been converted to NO_2, is characterized by the rapid accumulation of O_3 and other oxidant and nonoxidant products.

Several mechanisms explaining the relationships depicted in Figure 6-55 have been postulated. Although these mechanisms differ substantially in chemical detail, they all show O_3 formation in the atmosphere to be the net result of the following main reactions:

$$NO_2 \xrightarrow[\text{light}]{\text{UV}} NO + O \qquad (6\text{-}4)$$

$$O + O_2 \xrightarrow{M} O_3 + M \qquad (6\text{-}5)$$

$$O_3 + NO \longrightarrow NO_2 + O_2 \qquad (6\text{-}6)$$

$$XO_2 + NO \longrightarrow NO_2 + XO \qquad (6\text{-}7)$$

$$2NO + O_2 \longrightarrow 2NO_2 \qquad (6\text{-}8)$$

where X is hydrogen (H) or organic radicals (R or RCO).

In the course of this reaction process, the NO product from the photolysis of NO_2 reacts rapidly with and consumes O_3 to regenerate the photolyzed NO_2. Therefore, unless other processes convert the NO into NO_2, O_3 is not allowed to accumulate to significant levels. However, other NO conversion processes do exist, mainly the reactions of NO with RO_x and, to a much lesser degree, with molecular oxygen (O_2). The reaction with RO_x occurs only when photochemically reactive organic compounds are present, in which case the reaction can be sufficiently rapid to cause the atmospheric accumulation of O_3 to significant levels. In the absence of reactive organics, the only NO conversion process parallel to the O_3-NO reaction is the reaction of NO with O_2; this reaction, however, is relatively slow and does not cause significant O_3 accumulation.

To date, very few analytical or observational studies have been undertaken relative to the impact of fossil-fuel-fired powerplant emissions on ambient O_3 concentrations. The studies that have been undertaken concern the O_3 concentrations within the powerplant plume.

Studies of the effects of a 1,200-megawatt coal/oil-fired powerplant in the Washington, D.C., area (Davis, Smith, and Klauber 1974) showed a depletion of O_3 in plumes downwind of the plant to distances of 24 kilometers and a net increase in O_3 concentration relative to the air surrounding the plume beyond 24 kilometers. However, other studies (Tesche, Ogren, and Blumenthal 1976) of three western powerplants revealed O_3 depletion within the plume in the vicinity of the stack and a gradual downwind increase in O_3 concentration to approximately background levels. No O_3 generation was observed in the plumes studied. These findings were confirmed by those of another study of coal- and gas-fired powerplants (Hegg et al. 1976). In this latter study, plumes were observed up to 90 kilometers (4 hours travel time) from the stacks, and O_3 concentrations in the plumes were found not to exceed those in the ambient air.

The extent to which NO_x emissions from the proposed Big Bend Unit 4 will affect the ambient O_3 concentration cannot be adequately modeled with available technology. However, since the emission of NO_x, the necessary primary pollutant precursor of O_3, is limited by NSPS, the impact of Unit 4 is not expected to be significant.

6.4.2 LAND

The burning of bituminous coal has several potential impacts on terrestrial ecosystems. Most notable among these are primary impacts of (1) gaseous pollutants such as sulfur oxides (SO_X) and NO_X, (2) particulate emissions, and (3) radioactive emissions. Secondary impacts include acid rain and the disposal of sludge and ash.

The EPA has established primary and secondary national ambient air quality standards (NAAQS). Primary standards are those necessary for the protection of public health, and secondary standards ". . . define levels of air quality . . . necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant" (40 CFR 50.2). Soils, water, vegetation, and wildlife are therefore directly protected by the secondary standards. Since plant emissions are not expected to exceed the NAAQS or allowable prevention of significant air quality deterioration increments (Tampa Electric Company 1979), it is unlikely that they will have significant adverse impacts on vegetation and wildlife.

Secondary ecological impacts often associated with transmission lines include (1) avian collisions, (2) effects of high-voltage electricity on biota, and (3) effects of management and maintenance of the right-of-way. Although some avian mortality may result from collisions with the transmission line, this right-of-way is relatively short (0.56 mile) and does not lie in the path of a major migratory corridor for waterfowl. The effects of high-voltage electricity on biota are poorly understood and unpredictable. Management of the right-of-way will probably be limited to periodic mowing in order to discourage the growth of woody vegetation. Secondary impacts of the transmission line, therefore, are not expected to have any irreversible effects on existing natural resources.

6.4.3 WATER

The water-use effect of Big Bend Unit 4 on the area water resources is considered a secondary operational impact. Big Bend Station Units 1, 2, and 3 presently receive their average freshwater requirement of 1.1 million gallons per day (mgd) from the Hillsborough County South/Central Water System. The permitted water withdrawal for Big Bend utilities is 1.85 mgd. The operation of the proposed Big Bend Unit 4 will require an additional 1.5 mgd of fresh water. Approximately 1.0 mgd of this additional water is needed for operating the flue-gas-desulfurization equipment.

The Big Bend Station will rely on Hillsborough County to meet the additional freshwater demand of Unit 4. The county is in the process of studying its water systems and has included Big Bend Unit 4 in its long-range plans. Potential sources of water for Unit 4 include the following (Tampa Electric Company 1980b):

1. The Hillsborough County South/Central Water System. This system presently has a total pumping capacity of 21.5 mgd derived from four subsystems: Brandon, Sun City, Ruskin, and Riverview-Gibsonton. Hillsborough County plans to add two well fields east of Brandon for an additional flow of 3.3 mgd. The water distribution lines will also be upgraded and expanded. Studies have shown that without these improvements in supply and transmission facilities, the Hillsborough County South/Central Water System cannot be considered a wholly dependable supply during peak flow conditions.

2. The Sun City Wastewater Treatment Plant. This plant is owned and operated by Hillsborough County. The plant produces 0.7 mgd of treated effluent and

is presently being expanded to a capacity of 3 mgd. The quantity and quality of the Sun City effluent are compatible with the intended water use at the Big Bend Station. Moreover, Hillsborough County is willing to provide this effluent for reuse by the Big Bend Station.

In addition to the identification of potential freshwater sources, the design of Big Bend Unit 4 will include an expansion of the existing recycling system, thus permitting significant savings of fresh water over that which would otherwise be required. Past records have shown that the use of recycled water has cut potable-water consumption by 21 to 23 percent.

Since the Hillsborough County South/Central Water System includes an area that is beyond the "5-mile radius area," it is possible that alternative water will be drawn from this outlying area and that water resources there will be adversely affected. The effects are not expected to be serious, however, for the following reasons:

1. Hillsborough County understands the water needs of the Big Bend Station, and they have been incorporated into long-range plans.

2. Earlier studies of the Hillsborough County system have shown that the supply system can be expanded by placing new wells to the east in the Brandon Area. This means that the water can be pumped from an area that does not experience heavy agricultural pumpage. Additionally, well field construction in this area should not have a great effect on saltwater intrusion.

3. The reuse of treated sewage effluent, in addition to providing relief from effluent disposal problems, will be a method of resource conservation.

Currently, there are no plans for future large industrial water use in the area. The phosphate industry in central Florida is expected to peak in the 1990s, then begin a decline. Agricultural use is expected to remain constant or decrease. However, the Hillsborough County Horizon 2000 plan has projected that municipal water use will increase. Increased pumping to serve growing municipal and industrial uses, together with periods of severe drought, could produce a substantial lowering of the potentiometric surface and thereby permit local contamination by seawater.

Hillsborough Bay, the source of once-through cooling water for Big Bend Units 1, 2, and 3, is also the source of once-through cooling water for the proposed Unit 4. The combined discharge of Units 1, 2, 3, and 4 will total 2,148 cubic feet per second (cfs), which will be returned to the bay. Consumptive use of circulating cooling water includes the water lost by evaporation. The forced evaporation rate is estimated at less than 5 cfs above natural evaporation rates in Hillsborough Bay. This increase should not produce any significant effect on the quality of the water in Hillsborough Bay and will not affect any agricultural, industrial, consumer, or recreational use of the bay.

There are several major water-related projects and operations within the Tampa Bay system. These include the Hillsborough Bypass Canal of the Four River Basins Project, the Tampa Bay Harbor-Deepening Project, the Mullet Key Beach Restoration and Erosion Control Project, continuing development of Port Manatee, and a proposed offshore fixed-platform berthing facility with a pipeline to a fuel facility at Port

Manatee. These projects are not expected to have any significant adverse impact on the Big Bend 4 Project (Tampa Electric Company 1980b).

6.4.4 PEOPLE

6.4.4.1 Socioeconomics

The secondary operational impacts of Big Bend Unit 4 include both induced employment and the effects of this induced employment on community facilities and services. This section discusses the secondary socioeconomic impacts that may arise from the operation of Big Bend Unit 4.

6.4.4.1.1 Induced Employment

The employment of 50 operational and maintenance employees over the operating life of Unit 4 will have the effect of stimulating demand for goods and services. Although a specific multiplier relating basic employment to service employment is not known, it is expected that one to two service-related employment opportunities would be created for every operational work force employee, or a total of between 50 and 100 new service-related employment opportunities.

6.4.4.1.2 Induced Expansion of Disposable Income

By inducing employment, the expenditure of wages earned by the Unit 4 operating work force will also contribute to a marked increase in disposable income and thus to an improvement in overall economic conditions in the area. If it is assumed that a significant proportion (50 percent) of the wages paid to the operating work force is spent in the Tampa area and that a multiplier effect of between 1 and 2 is operative, then the total annual disposable income attributable to the operation of Unit 4 could exceed the annual disposable income of the operating work force itself by approximately $594,250 to $1,188,500 (1985 dollars).

6.4.4.1.3 Tax Revenues Derived From Wages and Spending

The wages of operating personnel will constitute a new source of tax revenues. Assuming that 15 percent of total wages paid is spent in personal tax and nontax payments, approximately $210,000 (1985 dollars) per year will be contributed to all forms of taxation, based on national characteristics (U.S. Department of Commerce 1979). Of this $210,000 (1985 dollars), an estimated 25 percent will be spent in State and local tax and nontax payments, or approximately $52,500 (1985 dollars) per year.

6.4.4.1.4 Community Facilities and Housing

The induced employment and attendant population growth associated are not expected to place significant demands on the area's services or housing stock.

Table 6-68. Projected worldwide CO_2 emissions, 1965-2000[a]

Source	Emission rate (10^9 ton/yr)				
	1965	1970	1980	1990	2000
Coal	7.33	7.40	7.55	7.70	7.85
Petroleum	4.03	5.28	8.57	13.90	22.50
Natural gas	1.19	1.62	2.79	4.80	8.27
Incineration	0.46	0.51	0.61	0.73	0.88
Wood fuel	0.68	0.68	0.68	0.68	0.68
Forest fires	0.39	0.39	0.39	0.39	0.39
Total	14.08	15.88	20.59	28.20	40.57

[a] From Urone (1976).

Table 6-69. Particulate production estimates[a] (diameter <5 μm)

Source	Process[b]	Quantity (10^6 tons/yr)	Origin	Percent
Anthropogenic input				
Sulfates	g-a	276	Fossil fuel use	40
Windblown dust	p	180	Man's energetics	26
Hydrocarbons	g-a	72	Agricultural burning	10
Particulates	p	62	Agricultural burning	9
Nitrates	g-a	35	Cars and utilities	5
Industry	p	21	Fossil fuel use	3
Hydrocarbons	g-a	15	Fossil fuel use	3
Power and heating	p	10	Fossil fuel use	2
Other human	p	8	Miscellaneous solid waste	2
Nitrates	g-a	7	Agricultural burning	1
Fuel wood	p	4	Wood for heat	1
Forest fires	p	2	Man induced	1
				0
Total		692		100
Natural input (excluding volcanoes)				
Sea salt	p	500	Sea spray	46
Sulfates	g-a	335	Natural decay	31
Windblown dust	p	120	Wind	11
Hydrocarbons	g-a	75	Natural decay	7
Nitrates	g-a	60	Natural decay	5
Forest fires	p	3	Lightning, etc.	0
Total		1,093		100
Volcanic input				
Dust	p	25-150	Eruption	37
Sulfates	g-a	42-255	Eruption	63
Total		67-405		100
Grand total		1,852-2,190		

[a] From Dittberneck (1978).

[b] Key:

g-a = gas to aerosol conversion.
p = direct particle production.

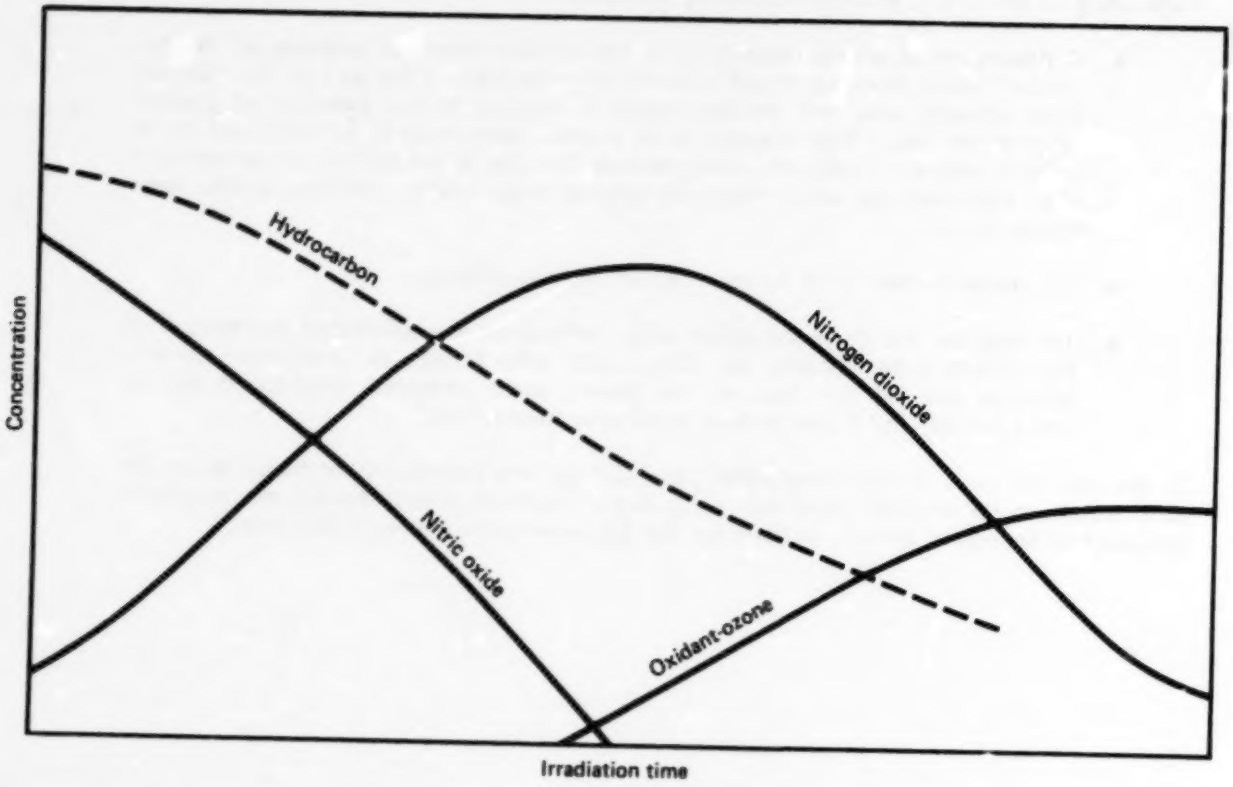


Figure 6-55. Chemical changes occurring during photoirradiation of hydrocarbon-nitrogen oxide-air systems.

6.5 LONG-TERM VERSUS SHORT-TERM IMPACTS

Short-term impacts are defined as those that will cease with completion of either the construction or operation of the proposed generating plant. Long-term impacts are those that continue to be felt after the plant has been decommissioned.

The construction and operational impacts of Big Bend Unit 4 are discussed in Sections 6.1 through 6.4. All the impacts discussed in these sections will cease with decommissioning of the plant, with the following exceptions:

- A maximum of approximately 97 acres of land used for disposal of the by-product from flue-gas desulfurization may be lost. (The size of the disposal area actually used will be decreased in relation to the quantity of gypsum by-product sold.) This disposal area cannot economically be returned to its original state. However, revegetation can be accomplished in accordance with expected use after decommissioning (e.g., wildlife habitat, public open space, etc.).
- The present channel of Jackson Branch will be altered.
- The use by the proposed plant of a portion of the allowable increment of significant deterioration for SO_2 could affect regional industrial growth patterns beyond the life of the plant, since patterns established during operation of Unit 4 would slow or reverse themselves.

If the site of Unit 4 and associated facilities is not eventually restored as much as possible to its original condition (with the exceptions noted above), the proposed project will foreclose various options for the future long-term use of this area.

6.6 COMMITMENTS OF RESOURCES

Three kinds of resources will be committed to the project: natural, man-made, and human. Natural resources that will be committed are air, land (including natural vegetation and wildlife habitat), water (including aquatic habitat), and the coal and other raw materials used to operate and maintain the facility. Man-made resources consist of the tools, equipment, and other items used to construct, operate, and maintain the facility. Human resources are the man-hours committed to the construction and operation of the plant, and the capital committed to the project.

The various resources that will be committed to the proposed project are to be committed either temporarily (for the life of the plant) or permanently (irreversible and irretrievable commitments of resources).

Table 6-72 lists the various resources that will be committed to the proposed project and identifies the nature of the commitment.

Table 6-70. Mechanisms that convert sulfur dioxide to sulfates

Mechanism	Overall reaction	Factors on which sulfate formation primarily depends
Direct photo-oxidation	$SO_2 \xrightarrow[\text{water}]{\text{light, oxygen}} H_2SO_4$	Sulfur dioxide concentration, sunlight intensity
Indirect photo-oxidation	$SO_2 \xrightarrow[\text{organic oxidants, hydroxyl radical (OH)}]{\text{smog, water, } NO_x} H_2SO_4$	Sulfur dioxide concentration, organic oxidant concentration, OH; NO_x
Air oxidation in liquid droplets	$SO_2 \xrightarrow{\text{liquid water}} H_2SO_3$ $NH_3 + H_2SO_3 \xrightarrow{\text{oxygen}} NH_4^+ + SO_4^{2-}$	Ammonia concentration
Catalyzed oxidation in liquid droplets	$SO_2 \xrightarrow[\text{heavy metal ions}]{\text{oxygen, liquid water}} SO_4^{2-}$	Concentration of heavy metal (Fe, Mn) ions
Catalyzed oxidation on dry surfaces	$SO_2 \xrightarrow[\text{carbon, water}]{\text{oxygen, particulate}} H_2SO_4$	Carbon particle concentration (surface area)

Formulas and symbols:

SO_2 = sulfur dioxide.
H_2SO_4 = sulfuric acid.
NO_x = nitrogen oxides.
OH = hydroxyl radical.
H_2SO_3 = sulfurous acid.
NH_3 = ammonia.
NH_4^+ = ammonium radical.

SO_4^{2-} = sulfate radical.

Fe = iron.
Mn = manganese.

Table 6-71. Resources that would be committed to the proposed Big Bend Unit 4 (Sheet 1 of 2)

Resource	Development phase	Nature of commitment
Natural resources		
Air	Operation	Commitment of up to 10% of the three-hour-average increment of significant deterioration for SO_2, 104% of the 24-hour-average increment of significant deterioration for particulates. This commitment will end when the plant ceases to operate.
Land	Construction through operation	Commitment of approximately 232 acres of land for the plant and associated facilities; this land will be committed to the proposed industrial use for the life of the project.
Vegetation	Construction through operation	Loss of 130 acres of vegetation, including about 57 acres of crop land, and 73 acres of pastureland.
Terrestrial wildlife	Construction through operation	Reduction of area wildlife populations.
Terrestrial wildlife habitat	Construction through operation	Loss of about 130 acres of potential wildlife habitat.
Aquatic biota	Construction	Loss of aquatic biota from construction areas in the discharge canal. The species lost will be replaced by other, probably similar, species after construction ceases, although the replacement populations may not be as dense as the present ones.
	Operation	Loss of some aquatic biota from entrainment, impingement, and thermal effects.
Ground water	Operation	Irretrievable loss of approximately 1.5 million gallons per day to the plant, primarily for the FGD system.
Coarse aggregate	Construction	Irretrievable commitment of 36,500 tons of coarse aggregate, a finite resource, to the project.
Fine aggregate	Construction	Irretrievable commitment of 22,500 tons of fine aggregate, a finite resource, to the project.

Note: See abbreviations at end of table.

Table 6-71. Resources that would be committed to the proposed Big Bend Unit 4 (Sheet 2 of 2)

Resource	Development phase	Nature of commitment
Natural resources (continued)		
Limestone	Operation	Irretrievable commitment of approximately 3.4 million tons of limestone, a finite resource, to the project. Some of this will be recovered as gypsum sold for commercial uses.
Coal	Operation	Irretrievable commitment of approximately 28.5 million tons of coal over the 30-year life of the facility. This represents a commitment of a limited natural resource. Some material will be recovered in the form of fly ash sold for commercial uses.
Fuel oil	Operation	Irretrievable commitment of 10,143 barrels of fuel oil, a limited resource, for start-up and flame stabilization.
Man-made resources	Construction through operation	Irretrievable removal from any other use of the tools, equipment, and other items used to construct, operate, and maintain the plant.
Human resources	Construction	Irretrievable commitment of the man-hours required to construct the facility (20,050 man-months, based on the estimated average number of workers per year, 1982-1984).
Money	Construction through operation	Irretrievable commitment of approximately \$558 million (capital costs), \$1.728 million (fuel costs), and \$406 million (operation and maintenance costs) to the project. This money would not be available for any other use.

Abbreviations:

SO_2 = sulfur dioxide.

FGD = flue-gas desulfurization.

6.7 UNAVOIDABLE ADVERSE IMPACTS

The impacts of the proposed project are discussed in detail in Sections 6.1 through 6.4. Those adverse impacts that cannot be avoided are the following:

- Release of pollutants into the atmosphere (Sections 6.1.1, 6.3.1, and 6.4.1)
- Commitment of land for the plant and its associated facilities (Sections 6.1.2 and 6.2.2)
- Loss of some wildlife habitat and some agricultural land and pastureland (Section 6.1.2)
- Loss of aquatic organisms during construction and operation of the plant (Sections 6.1.3 and 6.3.3)
- Loss of aquatic habitat due to thermal impacts (Section 6.3.2)
- Social and economic (direct and indirect) effects of the project (Sections 6.1.4 and 6.3.4)

6.8 PROJECT IMPACTS ON SPECIAL STATUS SPECIES (WILDLIFE)

The discussions in Chapters 2 and 5 indicated that as many as 80 species of wildlife of special status could occur on, or in the vicinity of, the Big Bend site. This number is conservative because of the range or habitat limitations at the site. Brown pelicans, eastern indigo snakes, manatees, and 19 other special status species have been observed at the site. Therefore, it is probable that a number of special status species could be affected by the construction or the operation of the powerplant.

This section summarizes information on special status species, their use of habitats at the site, and the expected impacts to the species. These species that are listed as endangered or threatened by the U.S. Fish and Wildlife Service (45 FR 242, 82, 480-82, 569) and may occur at or near the site are discussed in detail, especially because their habitats might be designated as critical by the Federal Government (44 FR 159, 47,862-47,868). The special status species (endangered, threatened, rare, and of special concern) designated as such by the Florida Game and Fresh Water Fish Commission and the Florida Committee on Rare and Endangered Plants and Animals are summarized in Table 6-72.

6.8.1 SPECIES INCLUDED IN THE FEDERAL LIST OF ENDANGERED SPECIES

6.8.1.1 Brown Pelican (Threatened in Florida)

6.8.1.1.1 Status at the Site

Brown pelicans have been regularly observed flying over the site and feeding near the mangrove swamp. They are expected to occur in the vicinity daily because of the presence of at least two rookeries in the county.

6.8.1.1.2 Expected Impacts

The impacts of construction include the possible siltation of feeding grounds and noise. Operational impacts may involve collisions with transmission lines or cooling towers.

6.8.1.2 Southern Bald Eagle (Threatened in Florida)

6.8.1.2.1 Status at the Site

Bald eagles have not been observed at the site, but several pairs regularly nest in Hillsborough County, and wandering or hunting individuals could use shore and aquatic habitats.

6.8.1.2.2 Expected Impacts

Since bald eagles do not nest at the site, activities related to construction or operation will not affect eagles breeding elsewhere in the county. Collision with structures or electrocution on powerlines is possible.

6.8.1.3 West Indian Manatee (Endangered in Florida)

6.8.1.3.1 Status at the Site

There are two designated critical habitats in the vicinity of the site (Alafia and Little Manatee Rivers), and there have been several manatee sightings in the saltwater aquatic wetlands that contain preferred food plants. The manatee studies conducted at Big Bend during 1979 (Patton 1980) indicate that the West Indian manatee regularly uses the discharge canal of the powerplant as a warm-water refuge during the winter months. Aerial sightings of manatees increased as ambient water and air temperatures decreased. The manatees moved in and out of the discharge canal in response to the occurrence of cold fronts and warming trends.

6.8.1.3.2 Expected Impacts

No destruction of habitat is expected from current construction or operation plans. The potential for cold shock due to plant shutdown should be reduced, as the probability of all four units going down simultaneously is lower than that of three units shutting down simultaneously. No adverse effects are expected as a direct result of the thermal effluent at the Big Bend Station. However, manatees in the discharge canal could be exposed to injury from fish nets and careless boaters. In an attempt to minimize the potential for injury, information signs have been erected to alert canal users to the presence of manatee.

6.8.1.4 Sea Turtles (Endangered in Florida)

6.8.1.4.1 Status at the Site

No sea turtles have been observed on or near the site during the wildlife surveys. Each of the four species (Atlantic loggerhead, Atlantic green, Atlantic leatherback, and Atlantic ridley) may occur rarely near the site in Tampa Bay. None of the species are expected to nest on the site.

6.8.1.4.2 Expected Impacts

No construction or operation impacts are expected.

6.8.1.5 Peregrine Falcon (Endangered in Florida)

6.8.1.5.1 Status at the Site

The peregrine falcon is expected to occur as a very rare migrant. It may use beach areas and mangrove swamps to prey on shorebirds.

6.8.1.5.2 Expected Impacts

Collision with structures or electrocution on powerlines is possible.

6.8.2 SPECIES INCLUDED IN THE FEDERAL LIST OF THREATENED SPECIES

6.8.2.1 Eastern Indigo Snake (Threatened in Florida)

6.8.2.1.1 Status at the Site

During the field survey, two individuals were observed in the Myrica-Baccharis association; other habitats at the site may also contain this species. The eastern indigo snake is expected to use the site for breeding, food, and cover.

6.8.2.1.2 Expected Impacts

The habitat in which the snakes were observed is not scheduled for disturbance by either construction or operation. Other preferred habitats, such as the pine flatwoods, will also not be disturbed. On the other hand, potential hunting territories in croplands and reclaimed areas will be used for new facilities, reducing the carrying capacity of the site as a whole. Noise may also affect this species and cause it to leave the site.

6.8.2.2 American Alligator (Species of Special Concern in Florida)

6.8.2.2.1 Status at the Site

Although no alligators have been observed at the site, 14 were seen on Beacon Key, and this species could occur at Big Bend. The site does not contain large areas of preferred habitats (large bodies of fresh water, swamps and marshes, etc.); however, alligators could use the brackish habitats along the edge of the mangrove swamp as well as the ditches and small ponds at the site.

6.8.2.2.2 Expected Impacts

The loss of any semiaquatic habitat like ditches, small ponds, or other wetlands will adversely affect this species. Most other disturbances can be tolerated.

Table 6-72. Checklist of special status species (Sheet 1 of 2)

Species	Expected at site	Local activity	Federal status[a]	State status[a,b]	Local habitat	Primary impacts[c]
Shellfish						
Mangrove crab	Yes	Resident		T	Mangroves	No long-term
Atlantic geoduck	Unknown	--		R	Subtidal	Siltation
Fish						
Atlantic sturgeon	Possible	Resident		T	Anadromous	Water pollution
Rivulus	Possible	Resident		T	Mangroves; salt marsh	Unknown
Opossum pipefish	Possible	Resident		R	Estuarine Brackish/freshwater	Unknown
Mountain mullet	Possible	Resident		R	Catadromous	Unknown
Terrestrial invertebrates						
Stock Island tree snail	No	—	t	T	--	--
Bahama swallowtail butterfly	No	—	t	T	--	--
Schaus swallowtail butterfly	No	—	t	T	--	--
Florida tree snail	No	—	u	—	--	--
Atala butterfly	Unknown	Unknown	u	—	Unknown	Unknown
Gopher tortoise copris beetle	Possible			T		
Peninsular gopher tortoise dung beetle	Possible	(d)		T	(d)	Loss of habitat
Gopher tortoise aphodium beetle	Possible	(d)		T	(d)	Loss of habitat
Southwest Florida wingless burrowing beetle	Possible	—		T	--	Loss of habitat
Abotis purse-web spider	Possible			SC	Mesic woods	No long-term
Scarab beetles (3 species)	Possible	Unknown		U	Unknown	Unknown
Amphibians/reptiles						
Florida crawfish frog	Possible	Resident		SC/T	Prairie; dry pine flatwoods	Loss of habitat
River cooter	No	--		SC/T	--	--
Gopher tortoise	Possible	Resident		SC/T	Prairie; dry pine flatwoods	Loss of habitat
American alligator	Possible	Resident	t	SC	Wetlands	No long-term
Eastern indigo snake	Yes	Resident	t	SC	Myrtle/saltbush, pines	Loss of habitat
Short-tailed snake	No	—		T/E	--	Loss of habitat
Atlantic loggerhead	Possible	Rare visitor	t	T	Estuarine	No long-term
Atlantic green	Possible	Rare visitor	e	E	Estuarine	No long-term
Atlantic leatherback	No	—	e	E/R	--	--
Atlantic ridley	Possible	Rare visitor	e	E	Estuarine	No long-term
Birds						
Wood stork	Yes	Feeding		E	Freshwater wetlands	Collision; no long-term
Peregrine falcon	Possible	Rare visitor	e	E	Mangroves	Collision; no long-term
Cuban snowy plover	No	--		E	--	--
Red-cockaded woodpecker	No	--	e	T/E	--	--
Eastern brown pelican	Yes	Feeding	e	T	Mangroves	Collision; no long-term
Southern bald eagle	Possible	Feeding	e	T	Near water	Collision; electrocution
Southeast American kestrel	No	--		T	--	--
Audubon's caracara	Possible	Visitor		T	Grasslands	Loss of habitat
Florida sandhill crane	No	--		T	--	--
American oystercatcher	Yes	Possible resident		SC/T	Beaches; mudflats	No long-term
Least tern	Yes	Possible resident		T	Beaches	No long-term
Florida scrub jay	No	--		T	--	--
Reddish egret	Yes	Feeding		SC/R	Saltwater wetlands	No long-term
Roseate spoonbill	Yes	Feeding		SC/R	Mangroves	No long-term
Little blue heron	Yes	Feeding		SC	Wetlands	No long-term
Snowy egret	Yes	Feeding		SC	Wetlands	No long-term
Rothschild's magnificent frigatebird	Possible	Visitor		T	Mangroves	Collision
Osprey	Yes	Feeding		T	Aquatic	Collision; electrocution
White-tailed kite	No	--		R	Grasslands; marshes	Collision; electrocution
Short-tailed hawk	Possible	Visitor		R	Coastal swamps	Collision; electrocution
Mangrove cuckoo	Possible	Resident		R	Mangroves	No long-term
Black-whiskered vireo	Possible	Resident		R	Mangroves	No long-term
Florida great white heron	Possible	Feeding		SC	Coastal	No long-term
Great egret	Yes	Resident		SC	Coastal; wetlands	No long-term
Black-crowned night heron	Possible	Resident		SC	Swamps; tidal marshes	No long-term
Yellow-crowned night heron	Yes	Resident		SC	Swamps; tidal marshes	No long-term

Note: See footnotes at end of table.

Table 6-72. Checklist of special status species (Sheet 2 of 2)

Species	Expected at site	Local activity	Federal status[a]	State status[a,b]	Local habitat	Primary impacts[c]
Birds (continued)						
Eastern least bittern	Yes	Resident		SC	Mangroves	No long-term
Glossy ibis	Yes	Resident		SC	Mangroves; marshes	No long-term
White ibis	Yes	Resident		SC	Coastal	No long-term
Cooper's hawk	Possible	Feeding		SC	Woodlands	No long-term
Piping plover	Possible	Feeding		SC	Beaches	No long-term
American avocet	Possible	Migrant		SC	Wetlands	No long-term
Royal tern	Yes	Resident		SC	Saltwater beaches	No long-term
Sandwich tern	Possible	Feeding		SC	Beaches	No long-term
Caspian tern	Yes	Resident		SC	Beaches	No long-term
Black skimmer	Yes	Resident		SC	Mangroves; beaches	No long-term
Southern hairy woodpecker	Possible	Resident		SC	Woodlands	No long-term
Prairie warbler	Yes	Resident		SC	Various	No long-term
Louisiana heron	Yes	Feeding		SC	Wetlands	No long-term
Limpkin	Possible	Possible resident		SC	Freshwater wetlands	No long-term
Florida burrowing owl	Possible	Visitor		SC	Prairies; pasture	Loss of habitat
Marians marsh wren	No	--		SC	--	Loss of habitat
Mammals						
Sherman's fox squirrel	No	--		SC/T	--	--
Florida mouse	No	--		T	--	--
Black bear	No	--		R	--	--
Florida panther	No	--	e	E	--	--
Manatee	Yes	Wintering; feeding	e	E/T	Saltwater, wetlands	Use of warmed discharge water; mortality from powercraft, poaching; habitat loss
River otter	No	--	u		--	--
Bobcat	No	--	u		--	--
Big brown bat	No	--		R	--	--
Rafinesque's bat	No			R	--	--
Florida weasel	Possible	Resident		R	Variety	Loss of habitat
Round-tailed muskrat	Possible	Resident		SC	Freshwater wetlands	No long-term

[a] Key:
E = endangered.
T = threatened.
SC = special status.
R = rare.
U = under review.
e = endangered (45 FR 99, 33768-33781).
t = threatened (45 FR 99, 33768-33781).
u = under review (45 FR 99, 33768-33781).

[b] Species status based on designation by either the Florida Game and Fresh Water Fish Commission (1979) or the Florida Committee on Rare and Endangered Plants and Animals (Tables 1-61 through 2-65; 1976).

[c] Possible secondary impacts are a decrease in environmental quality and reduction of habitat.

[d] Associated with the gopher tortoise.

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Chapter 7

MITIGATIVE MEASURES AND MONITORING PROGRAMS

The mitigative measures that the Applicant proposes to use during the construction and operation of Unit 4 to control intermittent problems of dust and surface runoff are described below, as are the methods for dealing with the off-specification operation of the flue-gas emission-control facilities. Other measures for controlling or eliminating the potential environmental impacts of Unit 4 are included in the descriptions of the proposed facility (Chapter 4) or in the discussion of impacts (Chapter 6).

The construction and operational impact monitoring programs that the Applicant proposes are also described below.

7.1 MITIGATIVE MEASURES

7.1.1 DUST CONTROL

7.1.1.1 Construction Dust Control

Fugitive dust generated by construction vehicles will be controlled by spraying construction roads with water. According to the U.S. Environmental Protection Agency (EPA), a 50 percent reduction of fugitive-dust concentrations at construction sites can be achieved by watering twice daily during dry periods (U.S. Environmental Protection Agency 1976; Jutze and Axetell 1974). Care will be taken to minimize overwatering, which could transport mud and dirt onto adjoining roadways, thus indirectly causing additional dust problems (Jutze and Axetell 1974). Any dirt or other dust-producing material that has been carried onto paved roadways will be promptly removed to reduce dust generation in these areas.

The use of dust retardants, windbreaks, dust fences, or temporary mulching to encourage vegetation on exposed and spoil areas will be considered where appropriate. Speed controls will be established for the mobile construction equipment to minimize the pulverization and abrasion of soil.

The construction impact control and monitoring program described in Section 7.1.2 will be implemented. Its purpose will be in part to ensure that these measures are enforced and that they are effective.

7.1.1.2 Operation Dust Control

The receiving, handling, and storage of coal for Unit 4 are sources of both controlled and fugitive particulate emissions. The limestone required for sulfur dioxide (SO_2) control system is also a potential source of fugitive particulate emissions.

Fugitive-dust emissions resulting from the receiving, handling, and storage of coal and limestone will be minimized by a combination of techniques. These include turning the reserve coal piles, which ensures uniform surface moisture; containment and control of transfer points, conveyors, and crushing equipment; and proper maintenance of coal- and limestone-handling facilities. These techniques are detailed in Sections 4.2.5, 4.2.8, and 4.2.10. Rainfall should help to minimize dust precipitation from wind erosion and mechanical disturbance. The mean annual precipitation in Tampa is 49.4 inches, with more than 0.1 inch of rainfall recorded on 107 days per year (National Oceanic and Atmospheric Administration 1979). Fugitive-dust emissions from the receiving and handling of limestone are expected to be minimal because of the particle size of the ore as received.

7.1.2 SURFACE-RUNOFF-POLLUTION CONTROL

7.1.2.1 Construction Impact Control

During the construction of Big Bend Unit 4, various measures will be taken to prevent or minimize the adverse effects of construction activities on the surrounding hydrologic environment (Tampa Electric Company 1980a,b; 1981).

The use of a temporary site storm-water drainage system and the quick restoration of areas disturbed by excavation will minimize site ponding, flooding, and erosion problems. Surface runoff will be intercepted and pumped to the wastewater-treatment pond. Where traffic patterns and plant layout permit, slopes will be reseeded to minimize erosion. Natural recolonization by pioneer and early successional forms of native vegetation should supplement reseeding efforts. Where necessary, netting, straw, mulch, or pavement will be employed to stabilize topsoil.

The use of oils, petroleum hydrocarbons, and greases will be controlled during construction in accordance with applicable State and Federal regulations to prevent these materials from entering surrounding water bodies through the site drainage system. Typical control measures will include the use of nondraining, impermeable slabs (where possible) or splash pans for liquid storage containers. Cleanup measures for oil and liquid-waste spills will be established.

All construction-generated trash and solid waste will be properly disposed of at an approved offsite disposal site. Construction personnel will use either portable chemical toilets or a temporary sanitary system that uses a package wastewater-treatment system. The wastes will be disposed of either off the site by a licensed contractor at approved locations or in the existing wastewater percolation/evaporation pond. These systems will be inspected and maintained regularly to prevent accidental spills or leaks.

The dewatering activity during the construction period will have only a localized and temporary effect and will not have a lasting impact on the ground-water system.

When dredging and other construction activities are performed in the discharge canal, measures will be taken so that turbidity levels do not exceed levels set by the Florida Department of Environmental Regulation (FDER) outside the work area. Typical control measures that may be used are dredge screens or sheetpile barriers. The discharge canal will be inspected weekly by boat to ensure that these measures are being implemented.

7.1.2.2 Operation Impact Control

Storm-water runoff from the existing Big Bend Station is drained into subdivided plant collection areas. The drainage system is designed to perform two basic functions. The first is to convey storm-water runoff from active plant areas with minimal ponding, erosion, and water quality degradation. The second function is to keep the storm-water runoff away from material storage areas in order to control the discharge of pollutants. The design of the retention system was based on the net runoff predicted for the design storm established by the EPA: a 24-hour storm with a recurrence interval of 10 years. Specific drainage systems that are to be used for Big Bend Unit 4 are discussed below.

Yard Drainage

The plant complex is situated on dredge fill consisting typically of highly permeable sand and shell material. Some isolated areas of grass exist. The main plant road and parking lot are paved, but other roadways are not.

The yard drainage system consists of several open, grass-lined ditches feeding into concrete catch basins that discharge to the bay. The parking lot drains to catch basins that subsequently discharge to the bay.

Areas where oils, greases, and other petroleum hydrocarbons are stored will be constructed so that spillage from these areas will not contaminate the storm water.

Roof Drainage

The roof of the existing main plant structure is equipped with drains that convey storm-water runoff to the bay. The Unit 4 building expansion will include similar provisions for roof drainage. Runoff from the auxiliary building roofs will drain to the ground, ultimately entering the yard drainage system.

Coal-Pile Runoff

Coal-pile runoff collection and treatment systems have been provided for Big Bend Station Units 1, 2, and 3 in order to achieve compliance with limitations established for the National Pollutant Discharge Elimination System (NPDES) permit. The existing system will be modified to provide for the coal field expansion need for Unit 4.

The system, as it presently exists, consists of an interception trench, a pumping station, and a runoff pond. The system is designed to capture and retain runoff resulting from the design storm (a 24-hour storm with a recurrence interval of 10 years). Runoff resulting from storms exceeding these design conditions is discharged to Tampa Bay.

To allow for Unit 4 coal storage, the coal-pile runoff pond will be eliminated. The existing interception trench will be expanded to encircle the new coal storage area, and the pumping station will be relocated. The modified system will then intercept all surface runoff, including that in excess of the 10-year, 24-hour storm, and pump it to the existing demineralizer-waste sump for transfer to the wastewater pond (Figure 4-6).

The coal-pile area drainage system for Units 1, 2, and 3 currently meets all NPDES requirements and will continue to meet permit limitations with the addition of Unit 4 (Tampa Electric Company 1980a).

Runoff from the FGD By-Product Storage and Disposal Area

As shown in Figure 4-15, the storage and disposal area for gypsum, the by-product of flue-gas desulfurization (FGD), will be developed in several phases so as to minimize the disruption of existing drainage patterns. Most of the disposal sites and adjacent areas drain into Newman Branch and adjacent wetlands. Any modification of the existing drainage patterns will continue to direct nongypsum pile runoff to these wetlands. The principal concerns in the design and construction of drainage modifications will be to minimize erosion and to maintain existing water quality. Berms designed to withstand a 100-year flood and storm surge will be constructed around the entire FGD by-product storage/disposal site. Storm water falling within the bermed area will be directed to temporary storm-water storage areas within the bermed area and allowed to percolate into the ground (TECO, 1981). No direct discharge to any body of water will occur.

Runoff from Bottom-Ash and Fly-Ash Disposal Areas

Storm water falling within the area contained by the bottom-ash berms will percolate into the ground. Storm water falling within the fly-ash berms will be collected and pumped, as needed, into the fly-ash disposal ponds.

7.1.3 AIR-POLLUTION MITIGATION

7.1.3.1 Background

Systems designed to limit major emissions of pollutants from the plant are described in Section 4.2. These systems include the (SO_2) scrubber system for flue-gas desulfurization, the electrostatic precipitator for particulate matter, and the combustion-modification method for controlling the emissions of nitrogen oxides (NO_x), incorporated into the boiler. The FGD process selected for Unit 4 to duplicate the highly reliable forced-oxidation, scale-control process commercially utilized in Japan, and by a conservative choice of construction materials for wetted gas-train components, high availability of the FGD system can be realized.

7.1.3.2 Potential Off-Specification Operation of the Flue-Gas Emission-Control Facilities

If particulate-collection efficiency of the electrostatic precipitator is temporarily lost because of equipment or system malfunction, the capability of the FGD system for particulate collection through wet scrubbing may be expected to mitigate against the resulting increase in particulate emissions from the stack.

If the FGD system (the final stage of stack-gas cleaning) becomes inoperative or is temporarily unable to meet gas-cleaning capacity requirements, the Applicant will take measures to operate the unit in compliance with the 30-day average SO_2 emission limitation as promulgated in the revised new-source performance standards (NSPS). Short-term SO_2 emission averaging will be accomplished using the continuous SO_2-monitoring equipment described in Section 7.2.

As indicated in Section 4.2.5.4.1, two-stage combustion operation will be initiated if appropriate testing indicates that NO_x emission standards under the revised NSPS are not met by the conventional tangential firing of the boiler.

7.1.4 GARBAGE-DISPOSAL SERVICES

A licensed contractor will be procured to provide garbage-disposal services. Contractors such as Waste Resources, Inc., the company that collects the garbage from Units 1, 2, and 3, have indicated that county landfills will probably be used for the garbage collected from Unit 4. They have also stated that Hillsborough County will have to provide other landfill facilities should the currently active landfill be closed.

On the basis of the construction experience at Big Bend Units 1, 2, and 3, the management of Waste Resources, Inc., feels that the Unit 4 construction waste volumes will not overburden either the handling capacity or the disposal capacity of the company. Moreover, no problems are envisioned with regard to using the present landfill for Unit 4 construction waste.

7.2 MONITORING PROGRAMS

7.2.1 CONSTRUCTION IMPACT CONTROL AND MONITORING PROGRAM

The following is a description of the Applicant's proposed Construction Impact Control and Monitoring Program (CICMP), which will be used to control the environmental impacts created by the construction of Big Bend Unit 4.

This program is applicable to all contractors and personnel performing work at the Big Bend Unit 4 construction site.

7.2.1.1 Responsibilities

The Site Environmental Engineer (SEE), an employee of the Applicant, is responsible for the implementation of this CICMP. The SEE will ensure that all environmental commitments made in licensing documents are met. He will make weekly inspections of all areas of the construction site during construction. The SEE is responsible for preparation and control of environmental problem reports and also for developing corrective action for the problems identified in these reports.

The Resident Engineer (Construction Manager) is responsible for all field engineering and design work performed at the site. The Resident Engineer will be the site liaison for the SEE.

The Superintendent of Construction is responsible for all construction performed at the site.

Site contractors are responsible for complying with the requirements of this section. This section forms the basis for a construction site procedure that will be included in all contract bid packages for work to be performed at Big Bend Unit 4.

7.2.1.2 Monitoring Programs

7.2.1.2.1 Water Quality

Storm-Water Runoff

Storm-water runoff will be controlled by a site drainage system and selected non-point-source erosion control measures like as hay-bale dikes, mulches, erosion control fabrics, and temporary vegetation, as necessary. Exposed soil areas that will not be used during construction will be stabilized to prevent erosion. During the weekly site inspection, the SEE will note the condition of the site drainage system and will identify erosion- and sediment-control problems in an environmental problem report.

Liquid Wastes

Liquid wastes like waste oils, lubricating agents, and liquid cleaning agents will be collected in 55-gallon drums and either disposed of off the site or in the existing site waste-disposal pond. Oil and liquid chemical storage containers will have drip pans under the outlet or nondraining slabs or liners underneath. Liquid wastes will not be disposed of in the site drainage system. The SEE will inspect all liquid chemical and petroleum hydrocarbon storage containers for leaks or spills. An environmental problem report will be written for each significant liquid-waste spill or leak.

Sanitary Wastes

Construction site personnel will use either portable chemical toilets or sanitary facilities provided in the construction office buildings. These facilities will be serviced by an approved sanitary-waste disposal contractor. The SEE will make weekly inspections of all sanitary facilities to ensure that they are properly maintained.

Shorefront Construction and Dredging Control

When dredging and other construction activities are performed in the discharge canal, measures will be taken so that turbidity levels do not exceed FDER standards outside the work area. Typical control measures that may be used are dredge screens or sheetpile barriers. The SEE will make weekly inspections of the discharge canal by boat to ensure that these measures are being implemented.

Ground Water

The existing ground-water-monitoring program will be continued during construction. The SEE will inspect the site area for potential sources of ground-water pollution and will identify any found in an environmental problem report.

Sampling Programs

Sampling programs will be performed for construction site-water quality as required by the EPA and the Florida Department of Environmental Regulation.

7.2.1.2.2 Air Quality

Fugitive Dust

The SEE will make weekly inspections to ensure that the measures described in Section 7.1.1.1 are continually implemented and that they are effective.

Vehicular Emissions

Construction-vehicle emissions will be visually inspected by the SEE in order to identify vehicles requiring immediate maintenance. Regular maintenance of all equipment and vehicles will be performed to minimize air emissions.

Open Burning

Open burning in connection with land clearing will be in accordance with Chapter 17-5 of the Florida Administration Code. The Division of Forestry will be notified before burning. Open burning will not occur during Division of Forestry bans on burning because of fire-hazard conditions.

7.2.1.2.3 Solid Wastes

Trash and construction debris will be collected in dumpsters or otherwise contained and disposed of away from the site. Waste concrete will be used wherever possible for erosion control. The SEE will make weekly inspections to ensure the proper collection and disposal of construction waste.

7.2.1.2.4 Noise

It has been predicted that construction sound levels will be similar to or less than the existing ambient sound levels from normal construction activities and that construction noise monitoring will be unnecessary. However, if valid complaints concerning noise from construction activities are received, noise measurements will be made as necessary to determine the noise source and mitigative measures will be developed.

7.2.1.2.5 Terrestrial Ecology

The following terrestrial ecological parameters will be noted by the SEE during each weekly survey of the site and any other areas used during the construction of Big Bend Unit 4:

- Intrusion into areas not previously selected for clearance or disturbance during construction
- Unusual changes in species composition or relative abundance (e.g., a sudden increase in rodent populations) probably attributable to construction activities
- Evidence of stress to existing vegetation
- Probable causes of vegetation stress
- Areas of new erosion that is not being mitigated at the time of the survey
- Effectiveness of existing measures for controlling storm-water runoff, including erosion- and sediment-control devices

Where ecological impacts regarding any of the above parameters are noted by the SEE, they will be reported in an environmental problem report, and measures will be developed and implemented to mitigate these impacts.

7.2.1.2.6 Aquatic Ecology

The construction impacts that may affect the biota of local waters can be separated into two types: impacts attributable to construction in the surrounding waters and construction-related discharges. Construction in local waters will be restricted to dredging, sheetpile erection, and dewatering in the discharge canal at the location of the Unit 4 discharge flume. The sources of construction-related discharges are given in Section 6.1.3.

In that these impacts will be routinely monitored as part of the water quality CICMP, it will be unnecessary to provide a specific program for aquatic ecology. The water quality CICMP is described in Section 7.1.2.

7.2.1.2.7 Traffic

Traffic will be confined to construction roads only. Areas designated for revegetation or stabilization will be clearly marked to prevent traffic movement through them.

7.2.1.2.8 Geology

The proposed station is to be built on driven piles, with a majority of the footings embedded at shallow depths. This type of construction requires minimal earthwork; therefore geologic or soil changes arising from construction activities are not expected. Earthwork associated with the construction of the ash pond and the FGD by-product disposal area will be routinely inspected by the SEE.

7.2.1.3 Program Implementation

The SEE will perform weekly site tours during which all areas identified in Section 7.2.1.2 will be inspected.

The SEE will attend weekly construction meetings to review current construction plans to ensure that environmental concerns will be met.

Inspection reports will be completed for each site tour. The SEE will maintain a log of all inspection reports.

Environmental problem reports will be completed for each environmental problem identified. The SEE will maintain a log of all such reports.

The SEE will prepare monthly reports of current environmental activities and problems at the site.

7.2.2 AIR QUALITY

Continuous in-stack monitors for opacity, SO_2, and NO_x will be installed for Unit 4. The opacity monitor will be installed in the flue- gas system downstream of the electrostatic precipitator, the SO_2 monitor will be downstream of the FGD system, and the nitrogen dioxide monitor will be downstream of the economizer outlet. These monitors will be installed, calibrated, maintained, and operated in accordance with Section 60.47a, Subpart Da, 40 CFR 60.

Tests will be made to ascertain that emissions of particulate matter, SO_2, and NO_x comply with the limits specified in new-source performance standards and in the Florida Administration Code.

These compliance tests will be conducted in accordance with Section 60.48a, Subpart Da, 40 CFR 60.

Potential SO_2 emissions will be determined by fuel analyses of both the raw and received coals, using procedures prescribed in the American Standard Test Method D 270 (1979).

7.2.3 OPERATIONAL MONITORING PROGRAM

The Applicant will submit an operational monitoring program 6 months before the scheduled commercial operation date of Unit 4, as required by Florida statutes. In addition, in accordance with NPDES (Part 3) conditions, the Applicant will implement a ground-water monitoring program.

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